DISCOVERY

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Notes of the Month.

Further testimony has come to hand that *Discovery* is a means of bringing information and entertainment to the outposts of the world. A New Zealand Correspondent writes: "I have been a reader of *Discovery* for three years and have grown to look on it as the one certain source of reliable up-to-date information. Since graduating seven years ago I have been in out-of-the-way places where good books and periodicals are rare and *Discovery* came as a most welcome relief to this dearth. I am accordingly sending you a clipping that may be of use to you, as a little effort on my part to assist in keeping the good work of the magazine going." The article to which he refers appears in this number, and we hope in future issues to deal more fully with the fascinating problems of the natural science of New Zealand. Overseas readers are reminded that we are always glad to receive news from abroad that may be of interest to their fellow-readers.

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Excavation is going on apace amid the sites of ancient civilisation. On another page we publish an account of the latest discoveries at Tell Duweir, the biblical Lachish, where the Wellcome Research Expedition has been digging for the past year. Meanwhile, as announced in *The Times*, Mr. Lansing, of the Metropolitan Museum of New York, has been excavating at Lisht, in continuation of the work begun by his Museum before the war. The group of pyramids at Lisht, some twenty miles south of the Step Pyramid of Sakkara, include the tombs of Amenemhet I and other kings of the XIIth Dynasty. Among the latest discoveries, now exhibited at Cairo, are a number of "dancing dwarfs" in ivory, a translation into three dimensions, as it were, of the famous "Dancing Men" of Sherlock Holmes. But the extreme realism, of their faces suggests a non-Egyptian origin, and, in connection with the discoveries of foreign art-influences in Egypt made by the late Dr. H. R. Hall, gives rise to interesting speculations.

At Deir-el-Medina, in the meantime, the French Archæological Institute has discovered some interesting domestic gear, notably some fine musical instruments and a lady's make-up box, which may be compared with the corresponding vanity outfit recently unearthed at Ur.

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At the Annual Inspection of the National Physical Laboratory, at the end of June, opportunity was given to representatives of the Press to review some of the more popular exhibits. In the Physics Department work has been in progress for some time (for the Food Investigation Board) on the problem of heat transfer between metal pipes and a stream of air passing over them. At the Laboratory the problem has been restricted to that of the transfer at the outer surface of the pipe, and the results for single pipes have been correlated by the principle of similitude. In the present number of *Discovery* the detection by light of hot or cold air streams is dealt with by Mr. H. G. Taylor; another aspect of the problems of temperature is reviewed by Mr. T. C. Crawhall in his article on "Dry Ice." A seasonal exhibition illustrating methods of refrigeration is open at the Science Museum, South Kensington, until the end of August.

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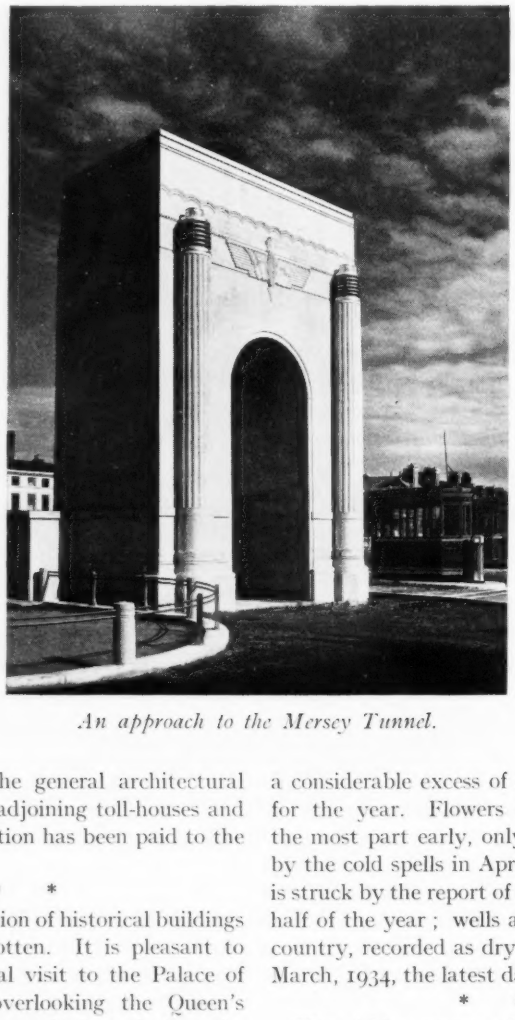
The newly equipped acoustics laboratory of the Physics Department at Teddington contains a reverberation room and a pair of transmission rooms together with associated measurement rooms. It provides unique facilities for the study of the absorption and the transmission of sound, employing large-scale specimens of materials. Complete acoustical and electrical isolation

of the experimental rooms is aimed at, the enclosing walls, floors and ceilings being massive and everywhere double, the inner shell resting on independent insulated piers. The rooms, which are asymmetric both in plan and elevation, facilitate in particular the study of noise transmission and abatement in relation to the design and construction of walls and floors of modern buildings, and the testing of acoustical absorbents such as are used for the treatment of walls and ceilings to assist in obtaining good hearing in various types of rooms and halls. By good fortune the principal opera house in this country is noted for its clear acoustics; but architects, who have long struggled with this problem, and those who have found themselves at the "blind spot" of other theatres or concert halls, will welcome this important step towards the advancement of sound research.

* * * *

The Royal opening of the Mersey Tunnel, which is destined to be the main channel of traffic between Liverpool and the South, is an occasion for universal satisfaction. The engineers and architects are to be congratulated, not merely on the successful outcome of the enterprise, but especially on the way in which they have worked together. The illustration on this page represents one of the great pylons at the Birkenhead entrance of the tunnel; its austere lines are typical of the general architectural scheme, and the design of the adjoining toll-houses and railing shows that proper attention has been paid to the smaller details.



An approach to the Mersey Tunnel.

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The restoration and preservation of historical buildings is not, in the meantime, forgotten. It is pleasant to learn that, since the last Royal visit to the Palace of Holyroodhouse, four rooms overlooking the Queen's rock-garden have been newly panelled, and that the portraits of Henry VIII and Queen Elizabeth (at present hanging in the bedroom of Mary, Queen of Scots) are destined for tactful removal. The Picture Gallery, however, has remained practically unchanged since Prince Charles used it as a ballroom in 1745. In the gardens it is difficult to imagine the troubles of the Austin Canons who first set up house here in 1128, and complained that it was no more than a forest, full of "hartis, hyndis, toddis, and siclike beistis."

* * * *

An interesting feature of the Annual Report of the Imperial Institute for the past year is the account of the discovery of platinum in several samples of gold ore assayed from the Kakamega goldfield in Kenya. The Plant and Animal Products department announces that lavender oil from South Africa has been found to be equal to the best French oil, and that, for the first time, mlanje cedarwood oil from Nyasaland has been commercially exploited. Some 1,300 enquiries were dealt with in the Intelligence Section, relating to nearly every country of the Empire. The majority of the applications fall into a number of main groups, the most important being enquiries regarding the marketing of overseas Empire products in this country, and the converse request for information as to supplies of raw materials from Empire sources.

* * * *

The Royal Meteorological Society's Phenological Report for 1933 announces, as might have been expected, a considerable excess of sunshine, dryness, and warmth for the year. Flowers and spring migrants were for the most part early, only a slight setback being caused by the cold spells in April and June. An ominous note is struck by the report of the serious drought in the latter half of the year; wells and ponds in many parts of the country, recorded as dry in September, were still dry in March, 1934, the latest date under review.

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West Africa, commenting on the article on the Carolina "bays" in our June number, mentions Lake Bosumtwi in Ashanti as having a possibly similar origin. Further observations from West Coast readers would be welcome.

The Greatest Eel-Farm in the World.

By James Hornell, F.L.S., F.R.A.I.
Late Director of Fisheries to the Government of Madras.

The little-known industry of eel-farming employs many workers in the lagoons of the Adriatic. The author gives a vivid picture of the strenuous work involved and, incidentally, of the humours and difficulties of approaching the scene of action.

Hidden away in the heart of that vast and dreary system of brackish marshes and lagoons formed in the course of the never-ending conflict waged between sea and river in the widespread delta of the Po, high up on the Italian side of the Adriatic, lives a quiet and industrious community of fishermen who cultivate these shallow waters as methodically as the agriculturist farms the stable earth. These people, inhabitants of the ancient city of Comacchio, are descendants of Roman subjects, who, driven from their homes by a flood of barbarians from the north in the middle of the fifth century of our era, sought refuge in the bosom of an immense marsh which their skill and industry have transformed through the centuries into a gigantic system of fish-farms without rival in vastness of extent and richness of produce.

The object of the eels' rush to their breeding-grounds. Larval eels from the Sargasso Sea, part of the largest haul ever taken.

Comacchio remains unknown to the tourist, a place so far off the beaten track that when I enquired at the chief tourist agency in Venice as to the best means of travelling thither, an astonished clerk admitted that he was not quite sure, although he remembered that a similar enquiry had been made several years before, also by an Englishman. Consultation of various time-tables showed that it was necessary to travel by rail to Ferrara, thence by steam-tram to the little town of Ostellato, on the western edge of the fish-farm area, where, if I were in luck, a *diligenza* would be found to carry me the remaining thirteen miles to Comacchio. [To-day there is a steam-tram all the way.—*Ed.*] But it was doubtful whether I should be able to inspect the fishing operations unless I were provided with a letter of introduction. The help of the British Consul seemed indicated. He proved to be a very courteous Italian gentleman and he very kindly furnished me with a personal letter of recommendation to the Prefect of Ferrara.

In due course I reached Ferrara by noon the following day, where I found the Prefecture to be located in the magnificent mediæval castle of the princely house of Este, a huge embattled pile dominating the city as a stately oak overshadows a thicket of brushwood. Up the noble staircase to the Prefect's office ; a neat maidservant says the Prefect cannot be seen ; some little persistence and a small douceur brought the advice to return in an hour's time, when, perhaps, His Excellency might be visible.

The interval was easily filled in. My Italian courier knew where a dish of the most delicious and freshly made tagliatelli was to be had, together with a bottle of the best wine produced in the province. Both came up to expectations and when we had done there was just time for a hurried visit to the fine old Cathedral before returning to the Castle. The maidservant had fulfilled her compact and smilingly ushered me into the great man's presence. I explained briefly the purpose of my visit and handed him the British Consul's letter. Taking it in his hands, upside down as it happened, he looked solemnly at it, without reversing it. After a pause, long enough to suggest that he was reading it, he looked up and said, " This is quite irregular, the English Consul in Venice has no right to address me ; this province is outside his area. This request should have come through the Embassy in Rome." I suggested that it was too trivial a matter for the Ambassador, that the

Consul wrote semi-officially and that all I wanted was a recommendation to the officials at Comacchio to further my enquiry if it was in their power. This had no effect. The Prefect repeated all he had said before and added that he could not give orders—the fishery was a private concern and was not under the control of the Government. He could do nothing. Feeling decidedly annoyed, I told him I would return to Venice and report to the Consul that he declined to assist me. This had a greater effect than I expected. The Prefect altered his tune and became less difficult. Still maintaining that he had no power to help me, he promised eventually to send a telegram to the sub-prefect at Comacchio to give me any assistance in his power.

Hurrying away, I just managed to catch the noisy little steam-tram as it was leaving on its afternoon run to Ostellato and beyond. It was made up of half a dozen wagons laden with sugar-beet and a couple of passenger coaches filled with sturdy peasants. Outside the city the track, which runs along one side of the highway, skirts a broad canal for some distance and I noted with interest that the industrious Italian fisherman has borrowed from China the mechanical lever dip-net, suspended from the end of a derrick-like arm, operated by a windlass that alternately submerges and raises the four-cornered net.

Across the Marshes.

When Ostellato was at length reached, I did, indeed, find the promised *diligenza* awaiting the tram, but a crowd of bustling countrywomen in voluminous skirts, carrying huge baskets of vegetables, got there first and filled it to overflowing. Was there any alternative? Yes, a burly figure on the box of an antiquated and nondescript vehicle that had perhaps been a victoria in its prime, was volubly and insistently soliciting the honour of my patronage. Though the vehicle was shabby and dilapidated and the harness mainly tied together with string, the horse appeared sufficiently alive to serve the need of the moment. A bargain was soon struck, and we prepared to start. Closer inspection showed that the hood which was up was a fixture in that position, so preferring fresh air I disposed my courier inside and clambered up to a seat beside the jarvey. "Come close to me," he urged, "the spring on that side is weak; it might break." Not very hopeful, I thought. When I told the old fellow of my futile interview with the Prefect, he roared with delight. "Oh, so you do not know that he is always fuddled by midday; if you want to get any sense out of him, you must see him in the early morning," was his comment. Parenthetically I must explain that this incident occurred in pre-Mussolini days; all this has been altered, for the Duce has regenerated Italy and such abuses are memories of the past.

Our way lay for the most part along the crown of a broad earthen embankment skirting the northern side of the greatest of the artificial lakes or *valli* made by banking in and subdividing the lagoon area devoted to fish-farming. In front lay a treeless expanse of stagnant pond and marsh, stretching away without break to the eastern horizon. The time passed quickly; the driver was now so much my friend that he pooh-poohed the idea of interviewing the sub-prefect for assistance. "You may be sure the Ferrara Prefect has done nothing" he asserted, "he just wanted to get rid of you. But never mind, my brother is a *fattore* at the principal fishing station and he will show you everything." During the rest of the drive when he was not telling me how the eels and mullet are caught in the farms or pointing out objects of interest, he recited long passages from Petrarch, descriptive of the country we were in. Imagine an English cabby or taxi-driver quoting Shakespeare's descriptions of English scenery! Only once on this long monotonous road did we come across a house—a little inn with a deal table set out under a vine-covered trellis. The wine was thin and the grapes small and poorly grown, but hunger is good kitchen and both were as acceptable as though they had been of the finest quality.

A Marshland City.

The great bell of the gaunt grey cathedral of Comacchio was booming out the hour of seven as we entered the city, a place much larger and more important than I had expected. The streets were already empty of people and traffic as we drove up to the solitary *albergo*, and shops were few and unpretentious. As I was soon to discover, the city lives a life all its own, a life detached from the bustle and anxieties of the outside world; the people are all dependent, directly or indirectly, upon one central authority, which in turn has but a single source of revenue—the produce of its fisheries. These are the property of the Commune and are either worked directly by the employees of the Commune for the common good or else are rented out for a term of years to a commercial firm. The men-folk follow their calling after the fashion of the sea, working in shifts or watches throughout both day and night at fishing stations located on platforms of reclaimed land or ancient islets dotted here and there throughout this huge lagoon region. Relieved at intervals of twelve days for a few days' rest with their families living in the city, these men are paid a modest wage supplemented by a daily ration of fish which assures them a standard of living that exceeds that of many classes of workers

in Britain. Canals intersect the city in all directions, as in Venice ; the people live an amphibious life and much prefer a boat to any wheeled vehicle ; the water is their home and the source of their livelihood.

The little *albergo* proved a pleasant hostelry ; the food was excellent, for what these country folk do not know about the preparation of *pasta* in its various forms of macaroni, spaghetti, tagliatelli and so on, and of the finny inhabitants of the lagoons—eels, mullet, smelts and bass—is not worth knowing. And who can resist ample indulgence in a good strong wine when the bottles bear the name *Bosco d'Elisco*, produce of a vineyard on the broad sandspit or *lido* separating the lagoons from the sea ? But I have to admit that there was a fly in the ointment and a large and troublesome one at that ; the lagoon marshes breed noisy and extremely hungry mosquitoes ; without a mosquito net enveloping the bed sleep is out of the question.

Eel Farming on a Large Scale.

The way in which the fishing rights came into the possession of the Commune or Corporation of Comacchio is interesting. During the Middle Ages they were one of the chief sources of revenue to the Este family, Dukes of Ferrara. In 1598 Pope Clement VIII dispossessed the Estes and seized both the Duchy and the Comacchio lagoon, and it remained a papal possession until Napoleon seized it in 1797 during his campaign against the tottering Republic of Venice. Being loot which he could not remove to Paris, he wisely sold it to the Commune of Comacchio, which has held it ever since.

Eels constitute by far the chief product of the farming operations, the catch ranging from about 400,000 kilos. in a poor season to over one million kilos. in a good one. Most of this is marinated in spiced vinegar and the bulk of the produce was sold to Germany and Austria before the war. In the Middle Ages the kegs of marinated eels were carried on pack-horses along the historic road between Venice and Augsburg, the great artery of commerce in those days between Germany and the head of the Adriatic.

The Comacchio fish-culture region at the time of my visit consisted of a series of thirty-seven sections or *valli*, which for convenience I shall hereafter call "fish-farms." These lie between two branches of the delta of the River Po and have a combined area of about 90,000 acres. To each section is apportioned at least one fishing station where are situated the labyrinths employed to trap the maturing fish, the storehouses for gear and repair material, and the barracks where live the *fattore*, or foreman of the *valle*, and the company of fishermen under his control. The men live and mess together like soldiers in barracks, a necessity consequent upon the fact that the chief work of the year, the herding of the fish into the traps, takes place during the night. The life is hard, but custom and tradition render the men passively content, satisfied if they be allowed Saturday and Sunday on alternate weeks to spend with their families at Comacchio. They struck me as a fine body of men ; true handy-men they are, for their duties include the supervision of the entry of the fry from the sea during the spring, the repair of the dykes, the weaving of the reed screens, the construction of the labyrinths and sluices, and the collection of the mature fish. Repairs to the embankments and fishing stations are executed during the hot season (June to July) when the water in the lagoon is low.

The work of policing is done by a separate staff of over one hundred men who patrol the lagoon in light boats both day and night. Their duties are no sinecure for the surrounding villages are full of poachers and the area to be protected so extensive—the perimeter of the lagoon is 177 miles.

Ancient Coastlines.

The various fish-farms are divided from one another partly by natural tongues of land and chains of islets and sandbanks, and for the rest by artificial earthen banks which convert the islets and miniature peninsulas into continuous embankments. Where necessary the foot of the dyke is reinforced with rows of stakes. The earthwork itself is the sandy mud from the bottom of the lagoon ; sedges and grass are encouraged to grow on the slopes and edges to protect and consolidate the surface. The natural chains of islets nearly all run north and south, roughly parallel with the coast ; this suggests that they represent remnants of successive and ancient sea-bars, now stranded inland owing to the gradual extension seawards of the land by deposits of silt brought down by rivers, which the prevailing coastal current fashions into a bank running in the same direction as itself. The depth of water is never great in the fish-farms ; it generally ranges between three and four feet, but in times of drought large areas dry out.

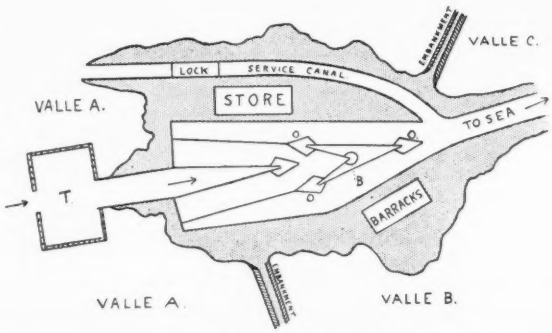
The fishing stations are located generally at places where natural islets originally existed. Here one or several canals are cut, connecting the water within the fish-farm with a wide channel on the outer side, leading to the sea. Except for a short period each year when the eel fry are due to arrive in their countless, jostling multitudes, the canals through each islet are blocked at their inner ends by wattled palisades which serve the double purpose of imprisoning the stock of fish within the farm, and of allowing some interchange of water between the lagoon and the sea. A second and more

elaborately built series of palisaded screens is set up on the approach of autumn in the form of a trapped labyrinth designed to capture the maturing eels when the awakening of the breeding instinct urges them to leave their inland home and head for the spawning grounds far out in the Atlantic where alone the European eel finds the conditions suitable for reproduction.

These labyrinths are most ingeniously constructed. Divested of detail a typical example may be described as a successive series of three V-shaped sets of very stout reed screens supported by heavy timber posts, having the open base turned toward the inner end of the canal and the apex directed toward the sea. The fish, mullet as well as eels, enter the second chamber of the labyrinth through a very narrow apical opening in the first with walls that give slightly as the fish press against them, springing back into position after they pass through. When in turn the fish attempt to leave this second chamber, again by a slit-shaped opening at the apex, the species separate automatically in passing out; the place where they find themselves is a heart-shaped trap without exit and with walls just stout enough to prevent the mullet from escaping, but not sufficiently thick to hinder the eels, fiercely determined to win their way to the sea, from forcing their bodies through the bundles of reeds. They succeed only to find themselves in a third and terminal triangular chamber having a small trap, also triangular in plan, at each of its angles. The walls of these traps as well as those of the main chamber are constructed in a most massive manner; the reed screen, composed of layers of reed bundles, is from seven to eight inches thick, supported by stout piles and secured in place by horizontal baulks of timber. Through these massive screen-walls there is no escape even for the most slippery of eels, possessed though they be with a frantic, overpowering desire to force a way to the sea at any cost.

This so-called fishing of the lagoon continues throughout October, November and December. Large catches occur only on moonless or overcast nights. When a storm from seaward coincides with the occurrence of such black nights, the quantity of fish that accumulates in the labyrinths is sometimes so enormous that the traps become choked with a solid mass of struggling fish. After one such night over 322 metric tons of fish were taken from them, as much as 64½ metric tons being yielded by one fish-farm alone. Quantities so vast are inconvenient to handle, so, whenever the workers find the fish accumulating too quickly in the labyrinths, they light bonfires at the inner ends of the canals and this has the effect of checking the migration temporarily.

The fishing season had just begun at the time of my visit. Never shall I forget the scene during the emptying of the traps. Standing on the thick summit of the reed palisade, lusty fishermen, stripped to the waist, their bodies glistening with sweat, lunged and twisted great dip-nets among the writing bodies of the eels imprisoned in the final traps; enough being caught, still greater effort was needed to raise the struggling mass of bronze-hued fishes. Slowly and with assistance the net came up and then what a mighty splashing when the contents were decanted into the store receptacles!

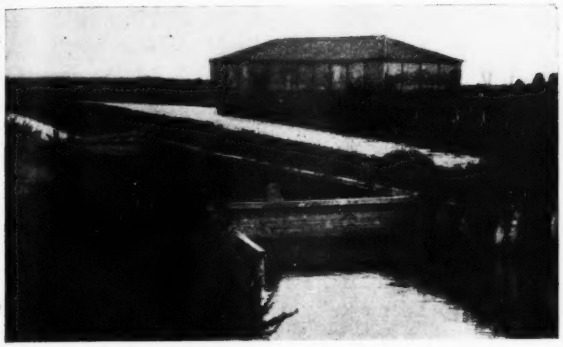


Plan of an Eel-Labyrinth.

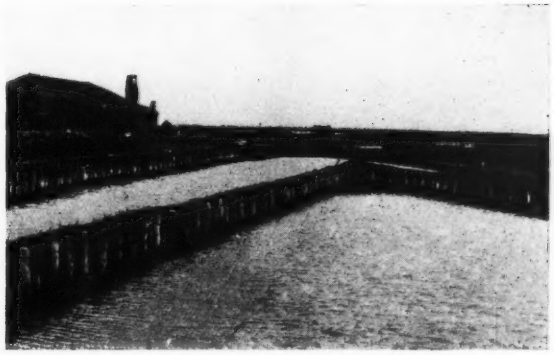
T. Entrance from the Fish-Farm (Valle A).
O. Heart-shaped traps where the eels are caught.
B. Rounded trap where the mullet are caught.

The night's catch, which was but a small one as the season was only beginning, having been stored away ready for despatch to the factory, all hands trooped back to barracks for the midday meal; the men insisted that I should join them—no men are more willing to share their crust with the stranger than the Italian peasant and fisherman—and so delicious was the savour that came from the mess-room that I very willingly accepted the invitation so kindly proffered. The *pièces de résistance* were broiled eels and grilled mullet, fit delicacies as then prepared for the most critical of gourmets, washed down as they were with wine of excellent flavour although it came out of a stoneware jar and had no distinctive name. Bunches of small but luscious black grapes, piled in heaps on the bare table, served as dessert, and then, finally, a little cup of excellent coffee and a small glass of the local cognac. Here, certainly, was no low standard of living.

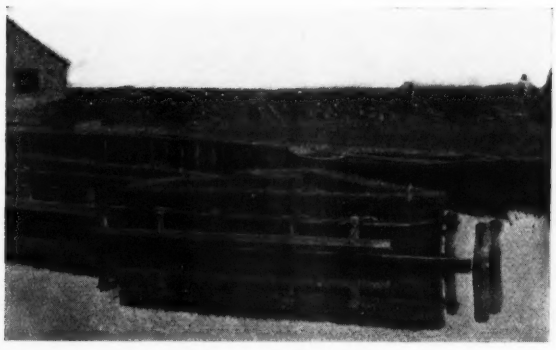
The next morning was spent at the factory in Comacchio. A barge had just come in filled with a writhing mass of eels all in the characteristic livery assumed when fully adult and ready for their seaward migration. The boat lay in a little basin at one end of a



A primitive lock with a storehouse behind.



The palisades of the eel-labyrinth.



The heart-shaped eel trap.

Hauling up the catch.

shed where a number of " headers " were seated before wooden blocks, each surrounded by several baskets. The eels, scooped up by means of landing nets, were filled into baskets and distributed to the headers whose operations consisted in chopping off the head of the living fish and dividing the body at intervals so as to give lengths of $4\frac{1}{2}$ inches to each. Only at alternate intervals was the body cut right through ; at the other points it was merely nicked deeply, to allow the halves of each double section to be folded upon themselves.

As the baskets are filled with the severed sections, they are carried to the roasting room where they are spitted and then cooked before roaring fires in open hearths. This room extends the full length of the building ; the fires, eight in number, occupy the whole of one side, the spitting tables the other. Between are wooden racks on which the filled spits rest before and after roasting. The spits upon which the double section of fish are transfixed are iron rods about seven feet long, provided with an L-shaped handle at one end, so that when hung upon a bracket at either side of the fireplace it may be turned by hand. Eight spits are ranged in vertical order before each fire. The four upper spits are tended by one woman, the four lower by a second ; both stand at the right-hand side of the fire as the handles are all placed on that side. These two workers attend solely to the roasting of the fish—to the proper rotation of the spits. Other women see to their placing and removal. The fresh spits with the raw fish are placed on the upper brackets ; the lower rows get the greater heat and as they are completed and removed those above are moved down to occupy their places. Wood fires are used and fresh fuel is frequently added to keep them blazing furiously.

As the fish roast a considerable quantity of oil oozes out. This drips into a sloping gutter in front of the hearth and flows along it into an underground tank. When the roasted eels have cooled sufficiently they are stripped from the spits and arranged in orderly rows in circular shallow baskets which are carried outside and laid in the shade of a wide verandah to finish cooling before further handling.

Embryology and Predestiny.

By E. W. MacBride, M.A., D.Sc., LL.D., F.R.S., F.L.S.
Professor of Zoology at the Imperial College of Science.

The volume here reviewed treats its subject in a highly controversial manner; and Professor MacBride finds that some of the authors' conclusions are not always in agreement with the results of recent discoveries.

*This text-book comprises a handy and exceedingly well illustrated manual of recent advances in experimental embryology. In their extreme endeavour to be up to date the authors have added an appendix after the summary in order to cram in preliminary accounts of what they consider to be the most up-to-date and startling discoveries. Of the two authors Professor Julian Huxley is too well known to need any introduction—everyone, including those who, like the reviewer, differ widely from him, will agree that he is a most fascinating and brilliant biologist. Professor Huxley for years has devoted his attention to certain problems of experimental biology: it remains for discussion whether or not his methods of analysis are sound. Dr. de Beer is less well known; he has done some excellent work on the development of the cartilages of the vertebrate skull, but his acquaintance with experimental work is second hand and, as his previous publications have shown, his acquaintance even with general embryology is far from perfect. So when we read in the introduction such startling statements as that His "overthrew" the recapitulatory theory of Haeckel, statements calculated to make the hair of any competent embryologist stand on end, we are inclined to attribute them to the younger rather than to the older author. Both authors seem to be unaware that these crude attempts to explain the formation of the body of the chick embryo as a result of the pushings of one part against another due to differential growth, and to ignore its patent resemblance in many features to a fish, have completely broken down, and it has been shown that many of these features will develop even when the part in which they show themselves is isolated from the other parts.

Haeckel's Theory.

As experimental embryology is an unfamiliar science to many even of the scientific public it might be as well to begin by giving some idea of its nature and objects. Descriptive or ordinary embryology aims at giving a complete account of the stages which an egg passes through in its growth and attainment of the adult form. It is the undying merit of Haeckel to have pointed out that the basis of this process in all animals is an historical one, that fundamentally the animal passes through phases which reflect conditions which were permanent in the lives of its ancestors, that indeed it "recapitulates," though in shortened and blurred form, its own ancestral history. This theory encountered, both in Haeckel's day and after it, the most violent opposition and led to explosive controversy. What His did was to accuse Haeckel of bad faith in that he drew the same embryo three times giving it a different name each time in order to prove that the embryo of different kinds of animals were identical. Haeckel was silent, because he chivalrously declined to betray a subordinate: he had given three different embryos to his artist: but the latter, noticing their similarity, had drawn only one! But as our knowledge of comparative embryology grows, the truth of the Haeckelian or historical interpretation stands out so clearly that it is almost subconsciously assumed by comparative anatomists and embryologists; indeed those who affect like De Beer to decry it use reasoning in their descriptive work which has no meaning except it be true. One single instance—surely the latest—of its truth may be given. There exists a group of small unicellular organisms known as Dinoflagellata; they are free-swimming and marine and form a most important source of food-supply for many small animals which in turn support fish. The Dinoflagellata are usually coloured and feed like plants but a certain group are devoid of colour and feed like animals. Their characteristic features are the possession of two "flagella" or whiplike oars for propulsion; of these one stretches out behind whilst the other encircles the body lying in a horizontal groove. Now it has been discovered that some species of Dinoflagellata are parasitic on the skin and gills of other marine creatures. These parasites are utterly different from their free-swimming fellows; they are globular, devoid of flagella altogether and endowed with a suctorial apparatus by means of which they penetrate the skin of their hosts. Why are they called Dinoflagellata at all? Because when they are young they swim freely and have the characteristic flagella and horizontal groove of the Dinoflagellates. If this is not recapitulation what is it?

**The Elements of Experimental Embryology.* By Julian S. Huxley, M.A., Honorary Lecturer in Experimental Embryology, King's College, London, and J. R. de Beer, M.A., D.Sc., Jenkinson Lecturer in Embryology, Oxford. (Cambridge University Press. 25s.)

The science of experimental embryology aims at discovering how the egg grows to the adult condition, by pulling it to pieces, distorting it, grafting pieces of other developing eggs on to it and checking or stimulating its growth by chemical solutions, and drawing conclusions from the growth of the damaged egg. It follows that before an experimental embryologist even begins his work he should have a competent knowledge of normal embryology especially of the group which he is investigating, and our principal complaint against the authors is that they are not good comparative embryologists: and in this they resemble many other experimental embryologists. Were there space a long essay could be written on the "howlers" of many of the distinguished early embryologists.

The Experimental Side.

How is the student to be introduced to such a vast and uncorrelated mass of details? Surely only by the historical method of tracing in outline how the science has grown. But apparently from a journalistic urge, the authors after the first few pages introduce the latest and most exciting discoveries connected with what are called "organisers," which is to give an utterly distorted outlook on the subject. The ideas of His were purely theoretical: the first to perform actual experiments was Roux, who operated on frog's eggs with a red hot needle. He arrived at the erroneous conclusion that development was mosaic: i.e., that the egg was like a picture puzzle map, each piece destined to develop into a particular organ and able only to do that. He was followed by Driesch (quem conservet Deus!) who laid the foundations of the modern science and whose main conclusions have stood the test of time. It is astounding how little new (in principle) has been added to Driesch's synthesis by subsequent workers. Working with the eggs of the Neapolitan sea-urchins and starfish he showed that the blastula or hollow ball into which the egg develops is what he called "a harmonic equipotential system" in which any piece was capable of producing the whole. As development proceeds the developmental powers (which he called the "prospective potency") of each part became progressively limited, and he postulated a non-material "entelechy" which controlled and limited the development and which would make out of a distorted egg in which the parts were forced into abnormal positions, a normal embryo. Against Driesch it was urged by Wilson and Conklin that in some eggs there was a real mosaic development—that, for instance, in the eggs of worms and molluscs each part separated from the "blastula" would develop only into that which it would normally have produced had it remained in its original position. But Driesch himself was the first to describe such eggs, in the group of Ctenophora ("comb-bearers"), beautiful transparent globe-like creatures which float in the sea, and Driesch gave the correct explanation of the phenomenon. It was not, he said, the nuclei that had become specialised—they remained equipotential to the end, as indeed is shown by their identical structure. It was the surrounding protoplasm (cytoplasm) that had become specialised so that it could only develop in certain directions. Ultimately this happened in all eggs, but in the so-called "mosaic" eggs it took place earlier than in others. But how was this "stiffening," as Driesch called it, effected? This question was answered by Boveri. Taking the eggs of the thread-worm Ascaris, which of all eggs are the most specialised, he showed that whereas the statement was true of the ripe eggs that every part was predestined to grow only into a definite organ, nevertheless if the young egg were tested large pieces of the protoplasm could be shorn away without impairing the capacity of the egg to develop into a whole animal. Therefore the specialisation of the egg must have taken place during the ripening period and this can only be attributed to emanations from the nucleus. The nucleus is the modern example of the "burning bush" of Moses: it burns (i.e., it emits its substance) but remains unchanged. As, however, in cases where it is possible to displace nuclei from their normal positions it is found that they can be "juggled about like a bag of marbles" without altering the result; we draw the further conclusion that these emanations from the nuclei are intermittent and periodic and that the course of development—the phases which succeed each other—are produced by successive emanations from the nuclei.

The Function of "Organisers."

The same conclusion is reached by the study on which our authors lay so much stress, that of "organisers." These were discovered by Spemann in the eggs of newts in 1916 and shortly afterwards (and owing to the war, quite independently) by the reviewer in the larvae of Echinoderms. By an organiser is meant a small piece of tissue which when brought into contact with the body of an embryo will so alter its development that the part of the embryo's body touched by the tissue will grow into quite a different structure from that to which it would have given rise normally. For instance, the egg of a newt grows first into a ball of cells or blastula; the blastula then by an inpushing from one end becomes converted into a double-walled cup or gastrula, of which the outer layer forms the skin of the young animal and the inner layer the lining of the gut. The opening of the cup is called the "blastopore" and becomes converted into the anus. The first organs to be formed are

the nerve plate (the rudiment of the brain and spinal cord) and the notochord which is the gelatinous fore-runner of the backbone. The first is formed from the outer layer, the second from the inner layer beneath the nerve plate. If now a small fragment is removed from the lip of the blastopore and grafted on the flank of another newt gastrula it will force the surrounding tissues to grow into a second nerve plate and backbone, whilst the normal nerve plate and backbone grow in their proper places. The fragment which possesses these extraordinary powers is called an "organiser." Spemann thought that the powers emanated only from the living nuclei and Dürkhen following him invented the name " biological field " for the sphere of the influence of the organiser, a term which the present authors have adopted. But recently the surprising discovery has been made that the organiser can be replaced by an extract from the dead tissues and even from the tissues of other animals. If these statements are confirmed—and it seems to the reviewer that one ought to hesitate before accepting them—then the influence of the organiser is due to the emission of chemical substances. But the action of no chemical substance can explain the alteration of the growth-powers of skin cells into nerve cells ; the chemical substance is not the " cause " of the alteration of growth, it is merely the stimulus which calls into action powers of growth present but dormant in the part affected ; and the only rational conclusion is that *all* the cells of the body possess the power of giving rise to *all* parts of the future animal; in fact, that the blastula of the newt, like the blastula of the sea-urchin, forms a " harmonic equipotential system." If this is so it follows at once that in normal development there must be some power which controls and regulates the powers of these turbulent totipotential cells and this is exactly what Driesch called the " entelechy."

Can we approach any nearer a description and definition of this mysterious force ? Certainly the authors of this manual are unable to do this because by restricting their vision to the early embryonic, or what they call the "prefunctional " period of development they deliberately shut their eyes to the historical meaning of these phenomena. For no animal whether adult or embryo can be understood by reference to itself alone. If we take a wide view of the animal kingdom we find that development can be divided into two phases—(1) an embryonic, during which the germ is sheltered from the world and fed either from the food stored in its cells or provided by the womb of the mother ; (2) a larval, during which the young animal is free and has to fight for its own life and food. It is further evident that as time has gone on the embryonic period has been prolonged and that what were previously larval stages have been converted into embryonic ones. Now the organs of the larva are functional—they are growths of the body which reflect its response to the demand of the environment : those of the embryo are functionless rudiments. As every larval phase embodies the response to a different environment—reproducing the response of an adult ancestor—the corresponding growths of the embryo are therefore memories of larval responses, and the entelechy is therefore neither more or less than a composite memory representing the reactions of the whole race of ancestors to other environments. But the entelechy is stratified into a series of memories corresponding to the various larval phases : these memories become active one after the other and are embodied in the successive emanations from the nuclei.

We are led finally to the conclusion that the study of experimental embryology supports the recapitulatory theory of Haeckel derived from the study of normal embryology, and the conception we are led to make of the innermost constitution of the embryo recalls in an amazing fashion the Freudian theory of the structure and development of the human mind.

In conclusion we may say that the book before us is most valuable as a storehouse of recent experimental work beautifully illustrated—and in scientific books of this kind illustrations are all-important. But we regard the analysis of embryology embodied in it as essentially unsound. The authors make the not uncommon mistake of endeavouring to bring the Mendelian "genes" into harmony with the facts of embryology. The study of embryology provides the most scathing criticism of the whole idea that the Mendelian " genes " are in any way significant for evolution.

Business Archives.

THE formation of a Council for the Preservation of Business Archives is announced by Mr. Baldwin, Sir Francis Goodenough, Sir Josiah Stamp, and others. As men interested in the history of the economic life of this country, they have been struck by the scarcity of an important class of documentary evidence—the records of business men and firms. This scarcity is attributed not only to destruction by fire and accident, but to the elimination of old documents often dictated by shortage of office space. Still, Mr. Baldwin and the other members of the new council have every reason to believe that great masses of economic records still remain completely inaccessible in the the possession of firms or of families descended from business men. The first object of the new enterprise is to map out the ground by compiling a register of all business records over 100 years old.

Dry Ice as a Cooling Medium.

By T. C. Crawhall, M.Sc.
Of the Science Museum, South Kensington.

The problem of food storage is one of the most urgent under modern conditions. The successful use of solid carbon dioxide as a cooling agent has helped much towards a solution, though its exceedingly low temperature gives rise to further problems.

In the space of a lifetime the mechanical refrigerator has developed from its infancy to a stage of perfection in which it is a vital factor for the existence of the human race. Such a statement, which appears at first to be extravagant, is justified when it is realised that more than three million tons of food are imported annually into this country in refrigerated ships; an amount which averages about seven ounces each day for every man, woman and child in Great Britain. Some idea of what this means is obtained when it is known that the average weight of food consumed each day by one person is about two and a half pounds.

The first cargo of meat to be brought successfully from Australia arrived in London in 1880 and this was followed in 1882 by the first shipment from New Zealand, a country which to-day sends more than 80 per cent. of its exports in refrigerated ships. The importance of refrigeration to the Mother Country and to the Dominions is therefore sufficiently apparent to make further emphasis superfluous. Moreover, the necessity for large cold stores and for domestic refrigerators is by now appreciated; but what is not quite so well known is the immense and rapidly increasing importance of this comparatively new branch of engineering in many manufacturing processes. For example, in addition to the more obvious uses for ice and ice-cream manufacture, it enters into the manufacture of such diverse things as chocolates, margarine, biscuits, beer, optical lenses, golf balls, cinematograph films and artificial silk stockings. These applications have been chosen at random from a list of about three hundred.

This Month's Exhibition.

Two hot summers in succession have drawn more than the usual amount of attention to the advantages, in fact the necessity, of refrigeration, and it is appropriate that, there should be at the Science Museum in South Kensington an exhibition designed to illustrate the applications of refrigerating machines and the ways in which they achieve their purpose. Until the end of August visitors to the Museum will see how refrigerators are able to keep the air in an enclosed space at a controlled low temperature. They will also see in addition to the well-known applications of food storage and transport, models which have been specially constructed for the Exhibition to illustrate a few of the ways in which refrigeration enters into industrial processes.

One of the most recent applications of scientific discovery is the use of solid carbon dioxide on a commercial scale as a cooling medium. For many purposes it has replaced water ice and its particular use, known to everyone, is that of preserving ice cream at a low temperature in the thousands of tricycles now so familiar in all parts of the country. It is questionable, however, how many realise that the substance, sometimes known as "dry ice," which is used in these tricycles, is of almost as simple a nature chemically as water ice. The men who handle it daily very often regard it as a mysterious chemical and all they know of it is that it is very cold and that it should not be handled without gloves.

The Nature of Carbon Dioxide.

Every substance exists in three forms, or states, viz., the solid, liquid and gaseous states. Water provides probably the best example, as in two of its states, liquid and solid, it is provided by nature, while in its gaseous state, steam, it is also familiar.

Carbon dioxide suffers from the disadvantage that it has never been given a simple name but is always known by its rather lengthy chemical title. At ordinary atmospheric temperatures it exists only as a gas, and probably it is best known as the gas exhaled in the process of breathing or as the gas which is given off by plants and trees. As a solid and liquid it has been known to scientists for almost 100 years—the discovery of the solid is attributed to Thilorier in 1835—and the strange thing is that although the manufacture has formed one of the simpler experiments done in the earlier years of a school or college course in science, it was not commercialised until 1924, only ten years ago. The first factory was constructed in Montreal. In the next year dry ice was made on a large scale in America and its production very soon followed in this country. A system of distribution had to be built up and there were certain technical difficulties to be overcome. All this took a certain amount of time and it is only comparatively recently that it has been possible to obtain it easily in most districts. Very shortly it should be more readily available than water ice.

Having now obtained some idea of what this substance is, it may be of interest to consider some of its properties, principally those concerned with its use as a refrigerant. The main property, naturally, is its extremely low temperature, minus 109° Fahr., i.e., 141 degrees below the temperature of water ice. It is this low temperature which makes it necessary to handle it with gloves, not because it is cold but in order to avoid the blistering of the skin. The effect is the same as a burn and gives rise to the paradoxical statement that dry ice will cause a burn. Blisters are caused by a sudden local transference of heat through the skin and the effect is the same if this is due to a hot or cold body. Boiling water at a temperature of 212° Fahr. is sufficient to cause a blister although the temperature difference between the water and the body is only about 114°. The effect of solid carbon dioxide may be imagined when it is realised that the temperature difference in this case is 207°, nearly twice as much. Apart from this, carbon dioxide has no deleterious effects unless used in a room without adequate ventilation.

Making Ice Cream.

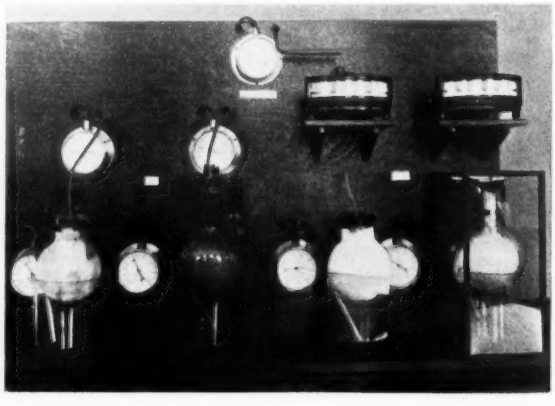
Due to this low temperature the first use (and still the largest use) of solid carbon dioxide was for the storage and transport of ice cream. Ice cream is made at a temperature of about 0° Fahr. and it will readily be seen that there was a demand for something which would keep the product at a temperature not greater than that at which it was made. Water ice was not satisfactory, although for many years before the introduction of this new substance it was used and the best was made of a bad job. The ice cream was very soft and the main disadvantage was that it melted quickly after being removed from the container.

The next property, which gives solid carbon dioxide a still wider scope and opens up a whole series of uses, is that it passes directly from the solid to the gaseous state, leaving no liquid behind it and in this it is vastly superior to water ice which, when melting, produces liquid water. This fact may appear to be a contradiction of what has previously been said, viz., that every substance can exist in three states. Carbon dioxide does exist in these three states but it happens that its boiling point is lower than its freezing point, a phenomenon very difficult for many to realise and one which occurs in only a few substances. Where a liquid is objectionable, dry ice has a great advantage over water ice. In this way it is replacing the latter for such purposes as the preservation of food in road or rail vehicles.

Many persons imagine that water ice will keep a space cool merely by the difference in temperature between the ice and its surroundings. A very elementary knowledge of physics will show that the cooling effect due to this temperature difference is very slight and that the cooling is obtained mainly by the heat required to change the ice to water, known as the latent heat of fusion. The heat required is, of course, obtained from the surroundings which in this way are cooled. A further advantage of carbon dioxide over water is that its latent heat is greater and in addition it can do useful cooling due to temperature difference alone.

An interesting experiment to show this effect provides the first exhibit in the Refrigeration Exhibition at the Science Museum. The apparatus, which consists of a number of glass flasks and dial temperature gauges, is illustrated here. The two left-hand flasks contain ice while the other two contain solid carbon dioxide. The left hand of each pair is a plain flask while its partner is of the Dewar type, i.e., it is double-walled with a vacuum between the walls. The contents of the Dewar flasks are slow to change their state because of the insulation provided by the vacuum space and on account of this they are unable to obtain heat from their surroundings with the result that the temperature in the space beneath the flasks is very little below that of the atmosphere. In the case of the plain flasks the temperature below is much lower than the atmosphere because of the heat extracted by the contents. The ice and solid carbon dioxide in the flasks changes from the solid state much more rapidly.

One might imagine that, because of its low temperature solid carbon dioxide would evaporate so rapidly that it could not be kept for a sufficient length of time to be of any use, but this problem was readily overcome. Firstly it must be stored and transported in heat-



Apparatus showing the comparative cooling effects of water ice and "dry ice."

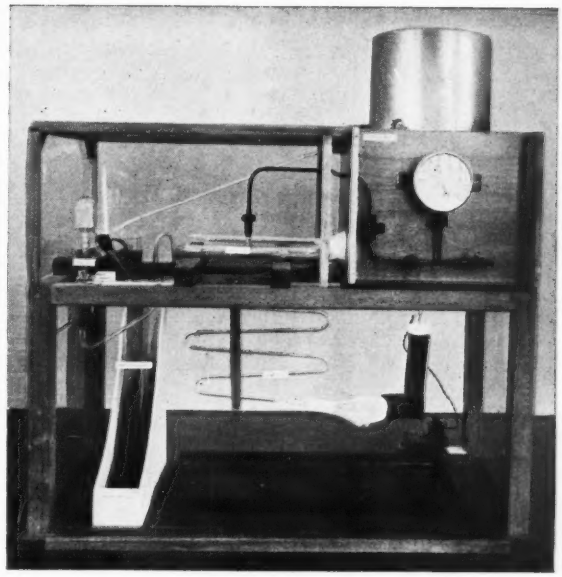
insulated containers, and secondly the containers must allow the gas to escape otherwise a dangerous pressure would be built up. It may thus be kept for several days with only a slight loss in weight. One outcome of its ease of transport and of the fact that it can be carried in light containers while occupying much less space than the gas, is that it is being found economical to carry it in this form even though at a later stage it may be required in the gaseous state.

At the Exhibition at the Science Museum, in an exhibit arranged by the Low Temperature Research Station, it is shown that the storage life of meat, fish and fruit is prolonged by the introduction of carbon dioxide gas, a truly remarkable development which will have a marked effect upon the feeding of the population of this country. It will be seen, therefore, that when dry ice is used as a refrigerant it has the additional advantage of increasing the time which the food in the cold chamber will keep in a good condition. Moreover, by penetrating the insulation of the chamber it improves the insulating properties.

This account should have served to show the very useful properties of solid carbon dioxide but, as might be expected, there is a fly in the ointment. Throughout the description it has been compared with water ice but it must not be supposed that it can entirely replace this useful substance. For ice cream preservation it has obvious advantages mainly because the temperature of water ice is not low enough for this purpose. When the temperature of water ice is low enough, as in most cases of food preservation, where the ideal storage temperature is somewhere between 32° Fahr. and the atmospheric temperature, solid carbon dioxide suffers from the disadvantage that, because of its low temperature, it is inefficient. Only a slight knowledge of thermodynamics is necessary to appreciate that, when heating or cooling, the greatest efficiency is obtained if the temperature drop between the heating or cooling medium and the surroundings is as small as possible.

Disadvantages of Very Low Temperature.

The best known example of this fact is the ordinary domestic coal fire which, because of the big temperature difference between the fire and the room which it is heating, is most inefficient. The same applies to dry ice. If it is cooling a cold chamber at a temperature of, say, 40° Fahr. the temperature drop is 149°. To overcome this disadvantage, and so to make better use of this new refrigerant, inventors have given it a considerable amount of attention. The illustration shows a working model of one of the systems employed as a remedy made in glass for the Science Museum Exhibition. The device is the joint invention of Nolcken and Maiuri and is now being actively developed. The apparatus works on the absorption system in which ammonia is the refrigerant, a system employed in certain types of refrigerators. In the ordinary absorption cycle the ammonia does its cooling by evaporating, after which it is absorbed by a weak solution of ammonia and the cycle is repeated. In the "Cold Multiplier," as it is known, the ammonia evaporates twice in each cycle. The first evaporation takes place in the compartment known as the generator, after which it is condensed by solid carbon dioxide in a double-walled container. The liquid produced flows to the evaporator where cooling again takes place and the cycle is completed by absorption as in the normal cycle. The outcome is that the cooling property of the solid carbon dioxide is multiplied because it is working at a reduced temperature difference. Theoretically the output is about 3.7 times more than that obtained by direct cooling with solid carbon dioxide, but in practice this is lowered to about 1.9 by unavoidable irreversible heat losses within the apparatus.



The "Cold Multiplier." Ammonia supplements the cooling power of carbon dioxide.

Among the other commercial applications of carbon dioxide in the gaseous state is the manufacture of aerated mineral waters and bottled beers; while in its solid state it is used by hospitals for cauterisation, in the form of "carbon dioxide snow," the product of the simple laboratory experiment mentioned earlier in this article.

British Spies in the American Revolution.

By R. B. Mowat, M.A.

Professor of History in the University of Bristol.

By no means all the American colonists were anxious to break with the mother country. Recent research has revealed the scope of the work of "Loyalist" spies and the difficulties thrown in their way by the intransigence of George III.

THE American Revolution or the War of American Independence was a civil war among the British people. The colonists took up arms in the defence of what they believed to be ordinary British liberties; and when the struggle began they had no idea of separation and independence. John Adams, one of their most determined leaders, wrote to a correspondent in England on October 4, 1775, about six months after the war had begun, and three months after the battle of Bunker's Hill:

"We cannot in this country conceive that there are men in England so infatuated as seriously to suspect the Congress or people here of a wish to erect ourselves into an independent state. If such an idea really obtains among those at the helm of affairs, one hour's residence in America would eradicate it. I never met one individual so inclined, but it is universally disavowed."

King George III.
A portrait from the studio of Allan Ramsay, reproduced by permission of the Director of the National Portrait Gallery.

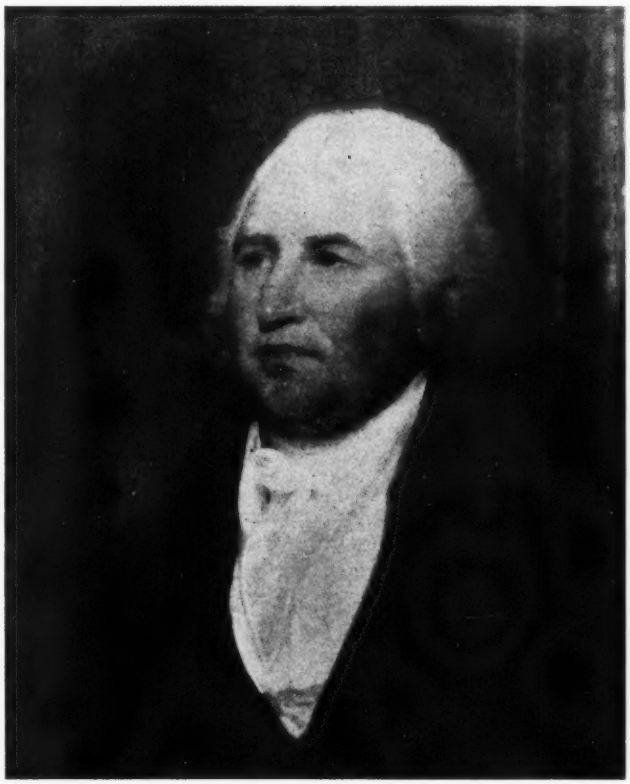
Nevertheless, although the Revolution (as the Americans call it) was only a civil war, a local struggle within the British Empire, the combatants took it very seriously. There was always a danger (which actually matured) that the struggle should become a European war on the grand scale through intervention on the part of France or Spain. The British Government wanted information about the secret relations of the Americans with the French authorities, and it maintained an elaborate spy-service in Paris and elsewhere through the period of the hostilities. A recent study, accurate, painstaking and skilfully written, of Mr. Lewis Einstein,* has reached the conclusion that: "No Government has ever been so well informed of the most secret doings of its enemies as was the British Cabinet." The spy-service was not merely very efficient. The information which it secured and passed on was, or could have been, of the highest value; it could have saved the situation for the British Government. Unfortunately, King George III, who kept the final direction of affairs in his hands, disliked secret agents, and was shocked to find that some of them were using their information for making some money on the stock-exchange. Mr. Einstein writes:

"Because the King had discovered that his American secret agents speculated on the Stock Exchange, he refused to believe in the seriousness of the news they gave to warn him of the impending French Alliance, which he regarded as tricks to depress the funds, and delayed until too late the concessions he was later ready to make and which if offered in time, almost certainly would have preserved his Empire."

The spies seem undoubtedly to have been, within the limits of their profession, honourable men. Those whose careers have been investigated by Mr. Einstein, were Americans who were loyal to the "Tory" side in the struggle. They believed that the British Government had right and reason on its side; or else they believed that in any case rebellion was wrong or not worth attempting. Therefore they were "Loyalist," adhered to the side of the mother-country in the civil war, and opposed the majority of their fellow-colonists. There

* *Divided Loyalties*. By LEWIS EINSTEIN. (Cobden Sanderson, 15s.)

was no American nation at that time. Many of the colonists, especially among the merchant class and the scholars, spent frequent and long periods in England, and were as much at home in London, where they had their chosen coffee-houses and clubs, as they were in Philadelphia, Boston or New York. Some of these Loyalist Americans were, or became, members of the British Parliament ; some became Government officials ; others fought in the British forces ; a few became secret agents. Mr. Einstein's account of them is based chiefly upon information taken from manuscripts in the Public Record Office and the British Museum, along with other material, published and unpublished, from Continental and from American sources.



Dr. Edward Bancroft.

Spy and Counter Spy

Early in the war, in March 1776, the Committee of Congress of the Thirteen Colonies sent one of their most zealous and capable servants, formerly a schoolmaster, Silas Deane, to France, in order to obtain arms and other supplies from the sympathetic French Government, and if possible even to obtain a French alliance. While in Paris, Deane was also to gain " information of what was going forward in England," by establishing contact with such American " Loyalist " residents in London as were willing secretly to help the rebel cause.

As soon as Silas Deane arrived in France he sent a letter to Dr. Edward Bancroft in London. The letter contained a draft for £30 and an invitation to Bancroft to come and see Deane in Paris. Bancroft was a native of Massachusetts who had made some money in sugar, and now lived in London, studying botany and chemistry, which he did with sufficient distinction to be elected a member of the Royal Society. As a boy, Bancroft had been a pupil of schoolmaster Silas Deane ; hence the connection between the two men now.

Bancroft came over to Paris, met his old friend, and gave him much information about affairs in London which Deane considered to be of the highest value and which he reported in his dispatches to Congress. On his side, Bancroft learned many interesting things. Deane had entered into communication with Count Vergennes, the French Minister of Foreign Affairs. King Louis XVI of France had not yet decided that the Americans' cause had sufficiently good prospects to justify his joining the war on their side. Vergennes did not judge it prudent, as yet, to deal directly with Silas Deane. He therefore employed an intermediary, the resourceful playwright Beaumarchais, author of the *Mariage de Figaro*. Beaumarchais solved the problem of the supply of French Government artillery and munitions to the Americans, while France was still at peace, by establishing a fictitious firm of merchants called *Hortalez et Cie.* with an ample supply of financial credit from the French Treasury. This company then purchased war-material from the French arsenals, and sold the guns and munitions to the Americans. This war-material helped the Americans a year later to win the battle of Saratoga, capturing a whole British army ; and then the French Government decided to make a firm military alliance with the American Congress.

Intrigue in Paris.

It is not possible to establish just how much information Bancroft obtained from Deane in Paris and passed on to London. Lord North, the Prime Minister, considered his reports of the highest value. Of course,

Lord North, or rather his very efficient Under-Secretary of State, William Eden, who was in charge of the spy service, did not trust Bancroft blindly; there were spies upon spies. Bancroft was shadowed by British agents in Paris and London and his private letters were opened in the British Post Office. He seems to have come through these tests all right and he was paid liberally for his services with a pension of £500 a year. He also, of course, received considerable sums from Silas Deane, for expenses incurred in "helping" the American authorities. He gave Deane quite a lot of information about the dispatch of troops from England for the theatre of war, information which, no doubt, the British War Office carefully supplied to him, in order to mislead the American generals. Unfortunately for him and for the cause which he was serving, the correspondence revealed to the British Government that he was trying to make a little more money by judiciously buying and selling stock at the right moment, and also by going into partnership with a member of the House of Commons, Thomas Walpole, in ventures for shipping contraband goods to the American rebels. These not altogether innocent transactions were, apparently, quite compatible with his being a perfectly trustworthy British spy; but George III did not think so, and never could bring himself to accept Bancroft's reports or to take sufficiently early action upon them.

A Would-be Gentleman.

Bancroft was a little mediocre, but the other spy dealt with in Mr. Einstein's book was quite a master. This was Paul Wentworth, an American of good family and of considerable property, a man of fashion and of affairs, well known in literary and in business circles of Paris and London. His conduct was justly considered to be irreproachable according to the standards of eighteenth century society, because his mistress was a lady of the highest manners and he gambled and speculated heavily, and always, most punctiliously, paid his debts. He seems to have been honestly a believer in the British cause, and although, as a British agent during the Revolutionary War he had a salary of £500 from the Government, money was not his object. He could have had a great deal more money from the Government, and in fact embarrassed the kind-hearted British statesmen a good deal by insisting upon paying his own expenses. Lord North became quite reluctant to send him on missions, fearing that Wentworth should be too much out of pocket. "As he absolutely refuses all indemnification," wrote the Prime Minister, "and indeed every sort of emolument except a place, I really am distressed when I propose to him the trouble and expense of these expeditions." The truth is that Wentworth's pathetic ambition was simply to be a complete English gentleman. He wanted the Government to provide him with a baronetcy and a safe seat in the House of Commons. The Government did have him elected to Parliament in 1780, but by this time the war was going badly, Lord North's Ministry was becoming highly unpopular, and Wentworth soon lost the seat. The baronetcy never came his way. All the ministers said that he deserved it; but each one left it for another to propose to the king; and George III himself was not going to take the initiative. The good king never seemed to take kindly even to his best spies. In fact, the better the spy, the less the king liked him, because the really good spies reported very unpleasant things about the movements of France and Spain and the successful diplomacy of the Americans; and kings, who are not used to being crossed, do not like to hear unpleasant things. Wentworth's contemporaries in America never learned about his doings. When the war was over he was elected to the governing body of Dartmouth College, Massachusetts, in which he had always been interested.

A Spy Outwitted.

This singular spy was sent by the British Government to Paris in 1777 after the American victory at Saratoga (October 17, 1777) had made it only too likely that the French would join with the Colonists. Wentworth had no difficulty in establishing good relations with the American commissioners in Paris—Benjamin Franklin, Arthur Lee and John Adams. His mission was either to prevent the conclusion of a Franco-American alliance or, if this were impossible, to obtain early news of it. Wentworth worked in concert with the other spy, Bancroft, whom the American Commissioners believed to be working in their interest. Efforts were made to induce Franklin to go to London, under safe-conduct, to negotiate a peace-treaty, on favourable terms, but not admitting the independence of the colonies. Franklin was not to be moved. A little later Bancroft, thinking to influence Franklin, gave him a letter received from London in which it was stated that the British Government was shortly going to make an offer of peace. In this letter, Bancroft was asked to enquire from the American Commissioners what terms they might be willing to accept. Franklin at once took the letter to Vergennes who was able to use it to induce his hesitating monarch definitely to decide to make an alliance with the Americans. The Treaty of Alliance was signed on February 7, 1778. Thus Franklin, though he did not know that Bancroft was a British spy, completely outwitted him. Wentworth had for weeks been sending warnings to the British Government that the alliance

was likely to take place, but George III would not believe him. When the alliance actually was concluded and made known (through Bancroft's espionage) to the British Government, George III suddenly became eager to make terms with the Americans, so that he could concentrate British resources on war with France. But now the Americans would consider no terms that did not include independence.

The conclusion of the Franco-American treaty of alliance put an end to Wentworth's and Bancroft's usefulness. At the end of the war, Wentworth went off to Surinam where he owned a plantation and there he died in 1793. Bancroft, after a lengthy visit to the new United States, came back to England and settled down happily to his researches upon dye-stuffs and the theory of colours. He died, a respected old gentleman and scholar, at Margate in 1821.

There was a third spy who was a master at his profession, the Reverend John Vardill, Assistant Minister of Holy Trinity, New York. This gentleman spent his time during the Revolutionary War chiefly in London; and through his connection with a keeper of a boarding house and an American sea-captain he was able to arrange for the theft of the complete correspondence which passed between the American commissioners at Paris and the French Court, covering the period between March 12 and October 7, 1777. For his services Vardill was made, by Royal Warrant, Regius Professor of Divinity at King's College, New York, and was given a pension. The success of the Colonists in the War made it impossible for him to take up the appointment at New York. He became vicar of Skerbeck and Fishtoft in Lincolnshire and died, highly respected, in 1811.

All this is only a slight indication of the copious, thrilling and authentic information in Mr. Einstein's remarkable book.

Climatic Changes in New Zealand.

Scientific investigators are bringing the knowledge of the Southern Hemisphere in line with that of the Northern. The details given below are taken from the "Dominion" of Wellington, New Zealand.

THE South Island of New Zealand to-day prides itself on its winter resorts; on its snow-capped mountains, and on its snow and ice sports, but not long ago as geologists reckon time—a mere two or three thousand years—it could with equal justice have prided itself on its sea bathing, on its mild winters, and on a climate almost sub-tropical in warmth. Between the years 1000 B.C. and 500 B.C., for a reason that is as yet imperfectly understood, the average temperature in both the Northern and Southern Hemispheres fell sharply, creating climates which we know at present.

This is one of the conclusions arrived at by Dr. C. C. Caldenius, a lecturer in geology at the University of Stockholm, who for the last seven months has been engaged on an investigation of the glacial and post-glacial deposits of the South Island, his object being the constructing of a geological and meteorological time-scale for the Southern Hemisphere.

Dr. Caldenius's work is a part of the general labours of the Geo-Chronological Institute of Stockholm, which is preparing a detailed time-scale based on geological observations of climatic changes which have affected the world at various periods in its history. The principal object of the time-scale is to determine the times at which the various glacial periods in the world's history occurred, how long they lasted, and what was their subsequent influence on climate.

A scale has already been prepared for the Northern Hemisphere, and Dr. Caldenius believes that his investigations here show that the climatic changes already proved in the Northern Hemisphere occurred simultaneously with those in the Southern Hemisphere. This knowledge proves, first of all, that the ice ages which at various times are known to have covered parts of Europe with seas of ice, were not merely local phenomena but were world-wide in their effects. This indicates in its turn that the cause of these ice ages does not lie in the earth itself, but in some outside influence, probably, it is thought, in changes in composition of the atmosphere.

Thus, before the last ice age, the atmosphere must have changed by some influence, and probably some similar, but less far-reaching change, occurred about 1000 B.C., resulting in a general drop in the world temperature.

These changes in the composition of the atmosphere are not yet fully understood, but it is believed that they may be caused by sudden outbreaks of volcanic action world-wide in their range.

It was in his studies of post-glacial deposits that Dr. Caldenius satisfied himself that New Zealand shared with the rest of the world the sudden drop in temperature that occurred between 1000 B.C. and 500 B.C. and created the present climate.

The Detection of Heat by Light.

By H. G. Taylor, M.Sc. (Eng.), A.M.I.E.E.

Apparatus for making air currents visible has been constructed by a team of young scientists. Striking results were attained and a commercial application of the discovery has already been made.

THE presence of draughts of warm or cold air is a matter of everyday experience, but their existence is only known by the sense of feeling or by their effects in disturbing light bodies ; the air currents cannot be seen. While there is no question about their existence, the indications which make them apparent are by no means sufficiently sensitive to give a very exact idea of their location or distribution. Further there is a minimum sensitivity to the normal detection of air currents which can only be increased by means of special apparatus. Thus the anemometer will revolve in a breeze which is imperceptible to the normal senses. In many cases it is very desirable to know the direction of motion of air currents and numerous methods have been devised for this purpose. A common method is the use of smoke, but this involves the difficulties of introducing it evenly into the air stream and of using the correct amount. An improved method is to paint the body, around which it is desired to examine the movements of air currents, with titanium tetrachloride. By contact with the air dense white clouds are then produced. Eddies and flow lines around bodies have also been shown up by dust figures.

Shimmering Heat.

These methods and others relate chiefly to cases where the air at rest and that in motion are at the same temperature and where the difference of pressure is small. If, however, a large pressure difference occurs, as with an explosive wave, or a small or large temperature difference two other methods are possible. One is known as the Dvorak or shadow method and the other as the Schlieren method or method of striae.

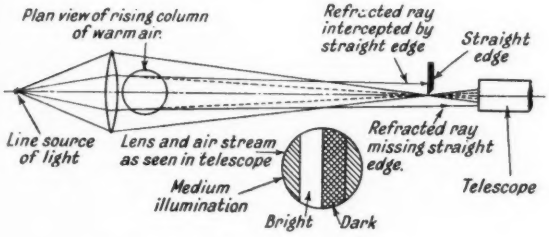
The two methods are fundamentally one in that they depend on the change of refractive index of air with pressure or temperature, as a result of which a beam of light passing through air in which a change of density occurs is deflected from the straight path. The Dvorak method may be considered as a crude and uncontrolled use of this fact ; the Schlieren method as a refined and controlled one. In its simplest form the fundamental effect of the Dvorak method may often be observed without any special apparatus and two examples of it are the " shimmering " of heat seen on a hot day across a road or field, and the same effect observed when looking at any object across the top of a hot body or through the funnel gases of a steam wagon. In these cases the rising hot air or hot gas, continually changing in position, causes continual variation of the angle of refraction and apparent position of the object viewed. If instead of viewing some object in this way one observes a screen illuminated by light passing through this hot air and gas, the movements of the latter may be observed. If a beam of light be allowed to pass through a hollow glass sphere and projected on to a screen a dark circle will be observed, on the inside of which is a bright circle. This is due to the fact that the light in passing through the outer edge of the sphere, in a plane at right angles to the incident light, is refracted towards the centre of the disc, because the refractive index of glass is greater than that of air. The outer dark ring is a shadow of the sphere and the brightness of the inner ring compensates for the darkness of the outer one.

Rays of light which strike the sphere nearer the centre are deflected in passing into the sphere but are again deflected in the reverse sense on leaving it and continue in their original path. If the refractive index of the shell were less than that of the air then the bright ring would be outside the dark one. Since change of refractive index is all that is essential it will be clear that a shell of hot air might quite well replace the one of glass, and this is in essence the explanation why warm air currents can be projected on to a screen merely by shining a beam of bright light through them. The great disadvantage of this method is the lack of contrast between the hot and cold air and the lack of definition, and the Schlieren method is very much better in these respects.

An Accurate Test.

In this method, which was originally used by Töpler in 1864, and is a development of Foucault's method of testing mirrors, rays of light from a bright source, such as an electric spark or one leg of the filament of a vacuum lamp, are brought to a focus by an achromatic lens on a straight edge parallel to the image. The eye, a telescope or a viewing screen is placed behind the straight edge. If, now, the image is formed entirely on the straight edge clearly no light enters the telescope, for example. If however, the straight edge is withdrawn and the whole image misses the edge, the lens will appear to be uniformly illuminated all over. For correct adjustment

the straight edge should be midway between these two positions. If now a stream of warm air rises near the lens on the far side from the source of light, the light rays will be refracted away from the axis, with the result that some which previously missed the straight edge are



Detection of Air Currents by Telescope.

now intercepted by it and the lens appears dark in that position, whereas others which were intercepted by the straight edge now miss it and augment the illumination on that part of the lens. Instead of observing, therefore, a uniformly bright lens one sees the convection currents in front of the lens brighter than the lens on one side and darker on the other. The optical arrangement is as shown above.

This is the essence of the Schlieren apparatus and is its simplest form. It is essential that the lens should be achromatic, or no precise focus exists and the image is coloured. It is also necessary that the lens should be of long focus in order to give sufficient real displacement of the image.

The first desideratum is not difficult to obtain for a small lens but if the area to be viewed is large the provision of a suitable lens is a very expensive matter, since the lens diameter must exceed the maximum dimension of the object to be viewed. A cheaper solution is to use a concave mirror and in this case the optical arrangement is as shown opposite.

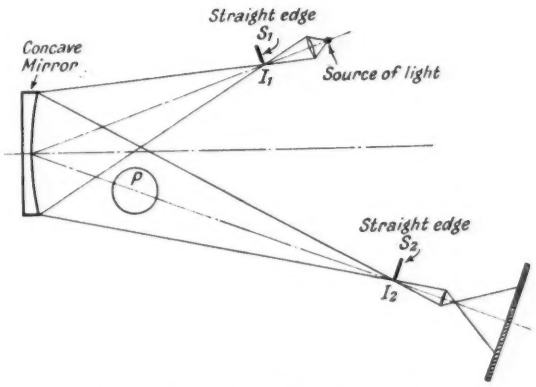
This also shows the use of a normal source of light such as a " pointolite " or arc light with the provision of two straight edges.

If the source of light be circular the image I_1 is circular, but the effect of the straight edge S_1 is to reduce this to a " *D* " shaped image. This acts as an object for the formation of an inverted image at I_2 which is almost completely cut off by the second straight edge S_2. The source of light is then, in effect, a very narrow straight line of light. When $S2$ is correctly adjusted the image of the mirror formed on the screen is of medium brightness. If now warm air exists at the position marked " *P* " rays of light from the mirror will be refracted away from the axis, as before, and will either miss the straight edge or be intercepted by it, and in consequence will either augment or reduce the illumination of the screen at corresponding points.

The vertical straight edge method is very simple to adjust but it is only sensitive to refraction at right angles to itself—any displacement of the rays parallel to the light source does not show up. This disadvantage may be surmounted by using the " hole and disc " method in which the source of light is circular—e.g., a " pointolite " lamp or a hole in a screen in front of an opal lamp —and is brought to a focus by the mirror on an opaque disc. In the position of critical adjustment the image just fits the disc and no light appears on the viewing screen. If any change of density occurs between the mirror or lens and the screen the light rays are refracted so that they miss the opaque disc and the viewing screen appears light at corresponding points. With this arrangement the apparatus is sensitive to deflections in all directions.

Photographic Results.

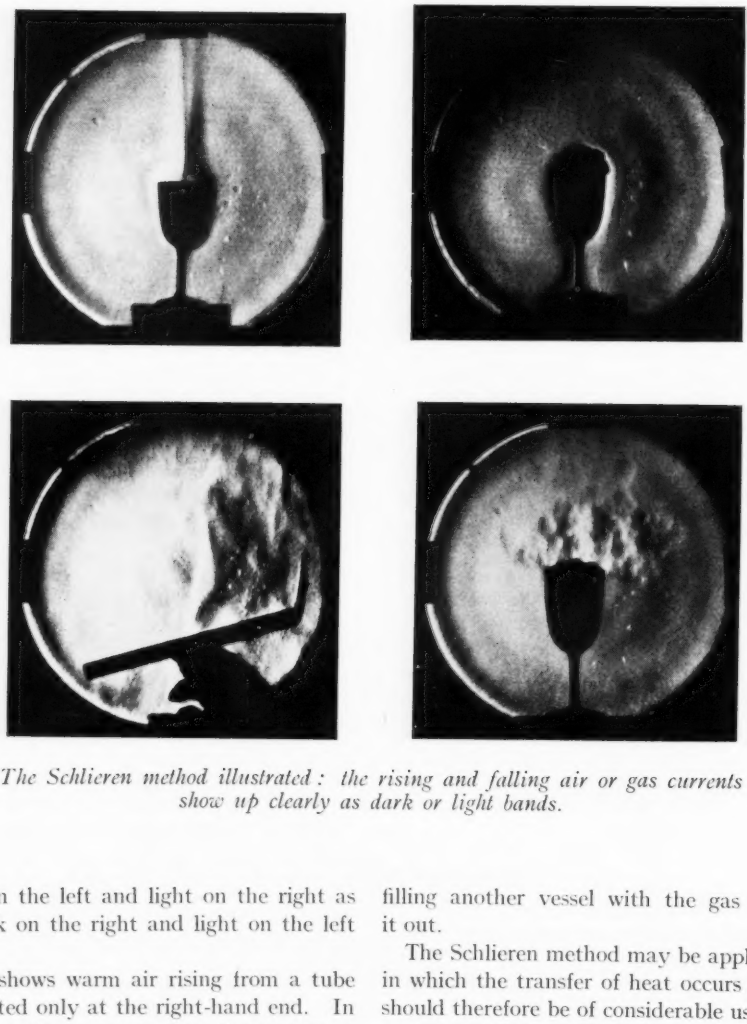
A number of typical Schlieren photographs taken with the straight edge arrangements are shown on the next page. First come an instructive pair of photographs showing warm and cold air currents. In the first figure is shown a wine glass containing hot water which heats the glass and gives rise to warm air currents. These it will be seen appear light on the left-hand side of the glass



Detection of Air Currents by Mirror.

and dark on the right, they flow over the rim of the glass and converge in a narrow vertical stream which may rise to a height of several feet in the absence of draughts. In the presence of draughts the stream is very easily disturbed. The next figure shows the same wine glass

filled with ice. The temperature of this being below that of the surroundings, the air in contact with the glass is cooled and, since this increases its density above the surrounding air, it falls. The refraction in this case is towards the axis and so opposite from the refraction when the air is at a higher temperature than the surroundings, and consequently the convection currents warm or cold air, and an example of this is shown in the last figure, which shows carbon dioxide generated by Fruit Salts. The photograph is taken at the commencement of effervescence when large bubbles of gas burst on the surface of the liquid. Immediately afterwards the gas falls around the glass with considerable rapidity, and a rather spectacular experiment may be made by



The Schlieren method illustrated: the rising and falling air or gas currents show up clearly as dark or light bands.

now appear dark on the left and light on the right as compared with dark on the right and light on the left in the former case.

The third figure shows warm air rising from a tube which has been heated only at the right-hand end. In addition to the convection currents from the surface of the tube warm air can be seen coming out of its upper end. The sharp difference between the cold and hot parts of the tube is striking.

As previously explained the presence of gases in the air causes refraction in the same way as the presence of filling another vessel with the gas and then pouring it out.

The Schlieren method may be applied to all problems in which the transfer of heat occurs by convection and should therefore be of considerable use to physicists and engineers. In many practical problems, such as those relating to the heating and ventilation of buildings, the constructions dealt with are far larger than any mirror which could be used, but in these cases the investigation may be carried out by means of models of the apparatus to be investigated.

Excavating a Biblical City.

By E. N. Fallaize.

The Wellcome Research Expedition has had a profitable season's excavation at Tell Duweir, the Biblical Lachish. A temple associated with an Egyptian cult has yielded pottery with interesting inscriptions.

DURING the winter season of 1933-34 the Wellcome Archæological Research Expedition to the Near East resumed excavations under Mr. J. L. Starkey at Tell Duweir, the site 25 miles south-west of Jerusalem identified with the Biblical Lachish. The expense of the expedition was borne by Sir Henry Wellcome, Sir Charles Marston and Sir Robert Mond.

In the previous year Mr. Starkey's excavations on the site (see *Discovery*, July, 1933) had revealed evidence of its occupation for a prolonged period extending back to the little-known Canaanitish era. A section of the levels had yielded a complete sequence of potsherds from the latest Jewish occupation back to the remote Copper Age of the fourth millennium B.C. The history of the city had been traced from the building of a stone-walled city of the Bronze Age, based upon an earlier city with walls of mud-brick, through a period of reconstruction in the Iron Age and the turbulence of the Jewish kingdom, when it was twice destroyed (the first occasion being identified with the sack of Lachish by Sennacherib in 701 B.C. and the second with the burning by Nebuchadnezzar in 586 B.C.), down to the age of the late remains on the top of the Tell, which make it a site unique in Palestine. These last were then cleared and found to consist of a building of the Jewish period with a later building erected over it, probably a residency of a Persian governor of the fifth or fourth century B.C.

At the opening of the season observations were made in the neighbourhood of the Tell with a view to ascertaining what were the relations of the outlying areas of the site with the central mound. That some relation did exist was suggested by the occurrence of pottery similar to that which had been found in the lowest strata of the section made in the previous year for chronological purposes. As a result of these observations, it was established that there had been a considerable suburban area dependent on the acropolis in the Copper Age. The extent of the site at this period has now been established as being at least 150 acres. This points to a centre of economic life which has, as yet, no parallel in Palestine. Included in this area is a dolmen, the largest and the most southerly in Palestine. At no later date was the area of occupation so extensive, and indeed from that time onward it shrinks until in the last phase, the period of the Jewish kingdom, it was confined to the top of the Tell.

Later in the season it was determined to begin the postponed operations on part of this suburban area. The area in question, extending in a northerly direction from the Tell across a valley running down its western side, is dominated by a limestone ridge. It was found that the ridge was honeycombed with pockets and natural caverns, filled with domestic debris, while at the foot of the ridge, where it joins the bed of the valley, the plough of the local cultivators had turned up evidences of burial. Operations were, therefore, begun forthwith in order to determine the area of the cemetery before any part of it might be under cultivation. It was found that the burials extended up the hill and joined on to the area of occupation. On clearing the caverns at the summit it was found that natural caverns had been artificially enlarged for use as dwellings by early Copper Age peoples. At a slightly later date they had been re-used as burial places. Some interesting material was here revealed including large groups of pottery vessels and beads belonging to the interments, though they had been badly disturbed in early times. The vessels are mostly flat-based. Some have ledge handles and a proportion have been finished with a hematite slip and have been burnished by hand. In the main they show hand-potting, but some indicate the use of a wheel in the finish of neck and rims. Metal is rare, but the occurrence of a copper dagger and pins show that metal was being used freely. A large biconic bead of

A Tell Duweir cave dwelling, with sunken storage-pits in the floor.

gold is unique for this period in Palestine. The technique of the carnelian, garnet, crystal and blue glazed beads is advanced, the beads being well cut and polished. One of the most interesting of the finds was a small beaker on the inside of which was the impress of a finely woven textile, showing that the inhabitants were acquainted with the use of the loom.

The temple sanctuary, showing the altar, and the cupboards for pottery utensils.

In the necropolis lower down the ridge, over 120 graves of the latest phase of the Copper Age culture have been recorded. The burial-chamber is oval and approached by a small vertical shaft. The bodies are found in a closely contracted position. As a rule each chamber contains one interment only, and multiple interments are rare. In the main the funerary equipment is a water jar, of flat-based ovoid form, usually of a light buff paste, a small squat jar with two handles at the base of a flared rim, and occasionally a flat open bowl. Four-lipped bowls, used as lamps, small weighted javelins and darts of peculiar form and daggers of more ordinary type, all of copper, are also sometimes found.

Turning now to operations on the Tell itself, sections of the building of the wall on the east side were examined to a greater depth than last year, and gave a better idea of the methods of construction, of which it was found that there were three stages. Large sections of the wall show traces of having been brought down by fire. In the burnt region above the road-way arrow-heads and pikes were found.

Under the revetment constructed of limestone rubble from the original cutting of the Hyksos fosse were some eight tombs, of which one was a small oval grave, just large enough to contain the contracted skeleton of a child. It also contained, closely packed at the foot, two vases, two bowls and a flask which will provide valuable material when the dating of the Hyksos defences has to be considered.

A curious feature in these earth defences, which are attributed to a people from the north, is a tunnel cut through the deep limestone packing high up the slopes and running parallel to the revetment and fosse. Its filling was partly water-borne silt, and partly its own collapsed roof. A length of the tunnel was exposed intact and it was found that its floor was covered with limestone dust. It is under four feet high and about four feet wide. It has been suggested that these may be saps dug by the Egyptian forces of the XVIIIth Dynasty. They may offer an explanation of the curious tunnels found at Tel Ajjul by Sir Flinders Petrie's expedition in 1931.

In clearing the fosse at the base of the Hyksos revetment a number of Jewish burials of the early kingdom were uncovered. They were mostly single, in a chamber at the side of a shallow shaft, and sealed by stones placed at an angle across the opening. The bodies were all extended with the hands at the pelvis. Sometimes a water jar was placed at the end of the grave and one or two smaller vessels by the head. It was at the level of these burials that were located the thick stone walls which subsequently proved to be a single building, constituting beyond question by far the most important discovery of the season's work. When completely revealed this structure proved to be a temple sanctuary with all its contents intact, except for damage by fire. The easterly end of the structure was better preserved, and stood to a greater height than the westerly, having been protected by later deposits of builders' rubbish. This small temple or sanctuary is square, and contains the altar with shrine behind and two small store chambers to the south. The entrance is to the north, through a narrow ante-room. Free standing benches are arranged on three sides of the sanctuary. In three niches or cupboards were pieces of pottery stacked intact. The most southerly niche contained no less than thirty-five pieces stacked in position. On the floor of the raised shrine was a large collection of toilet utensils in ivory, glass, and faience, together with scarabs bearing the name of Amenhotep III, notably one of the commemorative issues recording the killing of 102 lions by the king in the tenth year of his reign. Among the pottery vessels were libation bowls and bowls of peculiar form which possibly served for food offerings. A tall pottery stand was found on the right of the foot of the steps which lead up to the shrine. It had evidently carried a bowl of which remains were at its foot. On the floor was a pottery bowl for washing the feet and a pottery censer decorated with red ochre and with pierced lugs for suspension. To the left of the altar was a large

pottery bin. Presumably the devotees placed the offerings on the free standing benches, whence they were later removed by the attendants and deposited in the bin and libation bowl to the left and right of the altar respectively. It is probable that the building had a flat roof and that this was supported by the oval wooden pillars, of which the impress can still be seen on the top of the soft limestone bases. Of the two chambers attached to the shrine, that to the south-west was probably the vestry of the priests, as here were found beads from pendant floral collarettes of faience while the south-east chamber contained a mass of pottery probably fallen from a shelf.

Beyond the south and east wall was a great deposit of fragments and rubbish from the building. From the upper part of this deposit came a small faience plaque of Rameses II close to which were the fragments of the tall ewer decorated with figures of gazelles, trees and a lion, having, above and among these, a band of inscription in early Canaanitish script—the cause of no little discussion among scholars. The inscription is similar to two others which have been found, the one at Beth Shemesh, some ten miles from Tell Duweir and the other from Gezer. It is held that the inscription is in characters which are similar to those of the Sinaitic inscriptions found on rocks and monuments at Serabit el-Khadem in Sinai and also has certain affinities with the early Phoenician script of Byblos. Varying opinions have been given as to its translation; but there is a general agreement that the inscription reads from left to right and that the first three letters may read M T N —a "gift" or "offering." From this rubbish heap came also a fine inlay in ivory, a head bearing a strong resemblance to some of the Tell el-Amarna portraits now at Berlin. The treatment, especially of the eyes and their protruding lids, is quite distinct from the normal Egyptian technique.

From the moment the scarab and toilet articles were uncovered in the shrine it was evident that the excavators were in touch with Egypt. There can be no doubt that this building is a small temple and shrine of an Egyptian cult, as such placed outside the city wall; it was founded at some date not yet determined, but probably before the early part of the fourteenth century B.C. It was destroyed not later than 1262 B.C. as is indicated by the plaque of Rameses II. A fragment of inscribed pottery, it is conjectured, may include the *aton* sign and point here, too, to the cult of Akhenaton (Amenhotep IV). Faience daisies with yellow centres, etc., were common as pendants at the Tell el-Amarna.

The ivory finials and inlay head suggest the work of craftsmen from the North.

The Canaanitish inscription on this pottery ewer has been translated in several different ways.

On this point the Director, Mr. Starkey, has an interesting suggestion to offer, of no little importance for the history of Egyptian and Western Asiatic art. He suggests that all this ivory carving is the work of a northern, and not Egyptian, school of craftsmen, using the motifs and patterns in vogue at the time in the neighbouring countries of the Eastern Mediterranean. In this connection he notes in particular a perfume flask, carved from an ivory tusk, which came from the shrine. It is designed in the form of a lady wearing a long skirt, the loop handles representing shoulders and arms. A head which is fitted on the slender body serves as a removable stopper, through which a hole is drilled to connect with the hand-shaped spoon rising from the head. Similar tusk-like objects are shown on the wall-paintings of the XVIIIth—XIXth Dynasty tombs as carried by Syrian tributaries bringing gifts of local origin to the Pharaoh; and in the tomb of Sebekhotep, on a fresco now in the British Museum, exactly the same combination of female head and hand occurs. Probably this is the same school of northern craftsmen whose work appears later at Samaria.

The British Association at Aberdeen

The Meeting in Prospect.

FINAL preparations are now being made for the meeting of the British Association for the Advancement of Science to be held at Aberdeen from September 5th—12th. The President, Sir James Jeans, F.R.S., will contribute a message next month to the special number of *Discovery*, which will be published as usual on the eve of the meeting. There will be a detailed survey of the programme for the benefit of the members visiting Aberdeen, and for the even wider public which must be content with following the proceedings in the Press. Among the other contents will be a report dealing with new knowledge of termites, by Dr. Malcolm Burr, an account of the uncovering and cleaning of the wax figures at Westminster, by Mr. Lawrence Tanner, and a description of travels in Andorra by Lady Vyvyan.

The British Association is not, of course, new to Aberdeen. As already mentioned in these columns, an earlier meeting was held in that city in 1859, when H.R.H. The Prince Consort was President and delivered an inaugural address of great weight and vision. The Association again met in Aberdeen in 1885 under the presidency of Sir Lyon Playfair.

The city is of ancient origin. David I granted it corporate privileges which were confirmed by a charter by his grandson, William the Lion, in 1179. This charter is still preserved in the Town House.

The University of Aberdeen embraces two colleges, which up to 1860 were two separate universities, viz., King's College, founded in 1494, and Marischal College, founded in 1593. In early times, King's was devoted to the old faith, and later to Episcopacy, while Marischal was a Presbyterian stronghold. On the union of the two colleges, King's became the centre of the humanities and Marischal of the sciences. In modern times, and particularly of later years, the scientific development has been largely on the biological side—principally in the Rowett Research Institute, which is an associated institution.

The new President of the British Association, Sir James Jeans, was elected by the Council to fill the vacancy caused by the lamented death of Sir William Hardy in January last. Sir James will deal in his Presidential address with "The New World-Picture of Modern Physics"—a subject which will certainly attract a large and attentive audience.

Of the-ever popular evening discourses, one will be a memorial lecture for the late President, Sir William Hardy, which will deal with the subject with which he was closely associated—the preservation of meat, fish and fruit. The second evening discourse will be delivered by Professor W. L. Bragg, his subject being "The Exploration of the Mineral World by X-rays."

The new editor of *Discovery*, Mr. L. Russell Muirhead, will attend the Aberdeen meeting, and is looking forward to making the acquaintance of many readers.

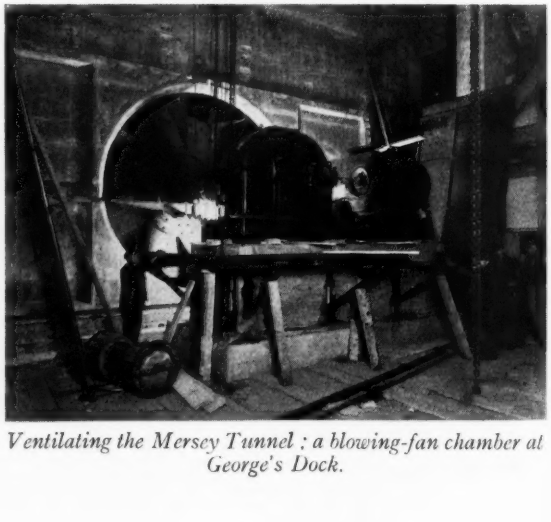
"Health Ray" Heating

AN electric heat-wiring system called the "Health Ray" has been evolved by Messrs. J. H. Taylor and Co., of Huddersfield. While not embodying an entirely new principle, this is an interesting development of the low-temperature panel heating system, using a different form of construction. The system is designed to produce low-temperature radiant warmth of the same kind as that produced in Nature by the heat of the sun.

During the summer months, widely distributed invisible rays slightly raise the temperature of everything in their path, e.g., the walls of a room. This slight warmth is, in turn, re-radiated and produces that condition of heat-comfort which renders every part of any room equally comfortable.

Insulated electric conductors employed in wiring systems for conveying electricity develop that slight degree of warmth which is equivalent to the warmth of summer and it is by suitably modifying and extending such wiring systems that buildings, etc., can now by the "Health Ray" system be wired with warmth exactly as they have previously been wired for lighting.

The heating is effected by a regulation wiring system which wires the entire building with warmth from the point of entry of the electric supply service. Alternatively, individual rooms can be wired with warmth and connected to the ordinary wiring system.



Ventilating the Mersey Tunnel: a blowing-fan chamber at George's Dock.

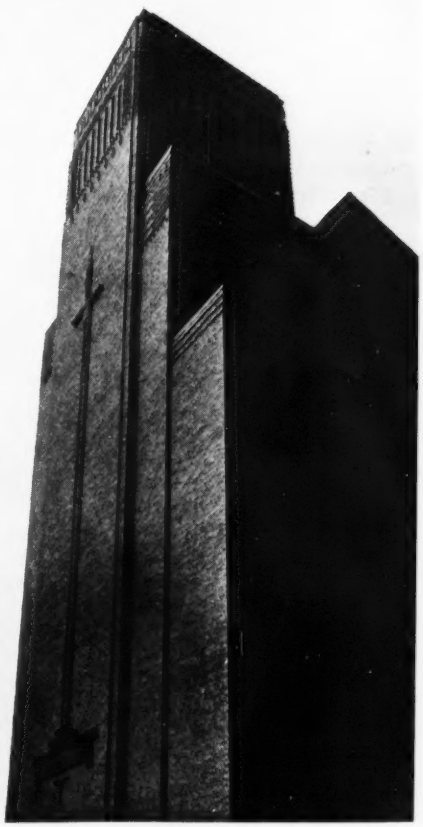
The Mersey Tunnel

The construction of the Mersey Tunnel solves one of the major traffic problems of England. The collaboration between architect and engineer is a hopeful augury for public works of the future.

TRAVELLERS between Liverpool and Cheshire have suffered for years under a grave disability. The direct way to the Wirral involved a wait—often a tedious proceeding, especially on a fine Sunday evening—for the Birkenhead or Wallasey ferry-boat; the only alternative was to make the detour by the Runcorn Transporter Bridge, an interesting passage though not a speedy one. All bars to rapid progress southward by road were removed on July 18th by the official opening of the Mersey Road Tunnel, or "Queensway," the largest under-water tunnel in the world, the first drilling for which was started on December 16th, 1925.

Some idea of the magnitude of this feat of engineering and building may be gained from the quantity of material excavated: nearly $1\frac{1}{4}$ million tons of rock and earth were removed, and 33 million tons of water were pumped out of the workings. The amount used of explosives and of concrete and metal construction material was on a corresponding scale. The main through line of roadway from Old Haymarket, Liverpool, to Market Place South, Birkenhead, is 2.13 miles long and 36 feet wide, capable of taking four lines of traffic abreast. From this artery diverge two narrower branches for the convenience of dock traffic, one on either side of the river.

In consonance with the reputation of Liverpool for fine building—St. George's Hall is probably the most successful recent Classical building in the world—the engineers and architect have worked together to produce a civic traffic unit as efficient in use as it is beautiful in design. The collaboration of the associated engineers, Sir Basil Mott and Mr. J. A. Brodie, with the architect, Mr. Herbert J. Rowse, has evidently been of the happiest, a good omen for future public works of this extent. In the pylons and road-approaches Mr. Rowse was presented a problem that would be the delight of any architect, and he has solved it admirably; his treatment of the Tunnel itself is appropriate in its bare simplicity, the dado of black glass tiles being relieved only by the fire-stations at 50-yard intervals and the brightly painted railings of the footways (for official use only) on either side. Lighting is contrived through vertical slots at 20-foot intervals, alternate lights being fed from alternate circuits in case of a failure in the electricity supply. The interval between the lights gradually increases as the tunnel-mouths are approached, so as to enable drivers to become gradually used to the difference between the interior and exterior illumination. Without ventilation the very existence of such a tunnel could not be contemplated, and the architect has accentuated the importance of this by the way in which he treats the six Ventilating Stations, three on each bank. Here he was faced by a problem without precedent, and he has dealt with it straightforwardly in a modern though not eccentric manner. The great ventilation buildings are an admirable expression of their function, which is to house the huge fans and the electrical switchgear that works them. The absence of the necessity for windows has led to an interesting variety of external wall-treatment. The ventilation plant being in each case duplicated, the buildings are symmetrical, apart from the Taylor Street Station, in Birkenhead, where an awkward site demanded special ingenuity.



Taylor Street Ventilation Station, Birkenhead.

We are indebted to the architect, Mr. Rowse, for the photographs reproduced here; further illustrations will be found in *Building* of May, 1934.

Book Reviews.

Name This Bird. By ERIC FITCH DAGLISH. (Dent. 7*s.* 6*d.*)
All About Birds. By W. S. BERRIDGE. (Harrap. 7*s.* 6*d.*)

These two books belong to that important class of bird literature which aims at making the intelligent nature lover more familiar with birds, and for that reason they are to be commended, because it is only when a knowledge of and interest in birds becomes universal that the national conscience will see that they are properly protected.

Mr. Fitch Daglish's book is written on the same plan as Gaston Bonnier's *Name This Flower*. There are two sections; the first of them is a "key" which, by putting before the reader a number of alternative questions at successive stages, is intended eventually to lead him to the identification of the particular bird seen. The second section gives short descriptions of species, with information as to their haunts, nests, food and calls. There are, in addition, coloured plates illustrating 237 birds and numerous black and white drawings.

To name an unknown bird by this system is obviously more difficult than to identify an unknown flower, because you can hold the flower in your hand while the bird remains in the bush. Tricks of light alter the appearance of birds in the field so greatly that it would be quite easy to start off on the wrong track at the beginning of Section I of the key, which gives the colour of the bird's upper parts. Testing the key myself, I found that where the plumage was striking I was given the right clues, but that where the colouring was complicated I strayed from the path. The details given in Section II are accurate and helpful. The plates vary; some of them are useful but in others the colouring is crude and the postures unlifelike. But in spite of these defects the book will be of assistance to many embryo field naturalists and deserves commendation if only for its ingenuity in applying this system of identification to birds.

Mr. Berridge has chosen an ambitious title for his volume, but if it is impossible to tell us "all about birds" in one book, he has managed to include an amazing amount of interesting information, and as a general survey of bird-life, both British and foreign, the book can be sincerely recommended to the general reader. It ranges from the edible swifts of China to the condors of Peru, and includes chapters on mound birds, migration, courtship, flightless birds, cuckoos, parrots, and extinct birds. Incidentally, it contains much bird-gossip, such as the fact that an ostrich's egg weighs three pounds and takes fifty minutes to boil, and that a boy bought at an auction for £1 16*s.* a miscellaneous assortment of shells, fossils and birds' eggs among which were two eggs of the great auk that subsequently sold for £456 15*s.* And there is the story of the Sassenach who looked a gift haggis in the mouth, and forwarded it to the Zoo. thinking it might suit the ostrich.

The description of the nest building of the wonga-wonga pigeon of West Australia significantly recalls Selous's theory that nests originated in the impulse—part of the sexual frenzy—to pick up sticks, etc. The male pigeon flies with a stick to his mate, walks round her two or three times, jumps on her back and presents his burden to her: she then arranges it beneath herself and thus the nest is made.

The field naturalist will cavil at some of the author's statements. The barn owl is not strictly nocturnal: I frequently see it hunting by day: nor is it in any district with which I am acquainted as common as the brown owl. Gannets, alas, no longer breed on Lundy Island. The incubation periods given on page 33 differ considerably from those given by other authorities and in some cases from my own experience. The common buzzard has increased rather than decreased in the West of England of late years. The book is illustrated by over a hundred photographs which reach a very high standard and add greatly to the attractiveness of the book.

Virgil the Necromancer. By JOHN WEBSTER SPARGO. (Harvard University Press. Oxford University Press. 21*s.*)

Among the many bypaths of literature and scholarship, one of the most curious and intriguing is that opened up by the reputation for magic and wonder-working attached to the poet Virgil in the Middle Ages. The poet, whom his contemporaries and succeeding generations regarded as divinely inspired, became the central figure of a group of tales such as were embodied in the *Gesta Romanorum* and other medieval collections, in which his actions and adventures are on a par with those of the other great magician of medieval tradition, Merlin, the resemblance even extending to the humiliation which each suffered through the trickery of a woman.

In these legends the centre of Virgil's activities is Naples rather than Rome, although some of the stories have the latter city as their setting As a wonder-worker the poet must be regarded as sufficiently public-spirited He makes a fly of bronze which keeps all flies from the city, his meat-market is capable of preserving the city's supplies for five hundred years, and his brazen figures of men guard the city, indicate the quarter in which the empire is attacked, or mark the passing of the seasons by tossing a ball from one to another. The poet's most notorious exploit, however, which has a special tang for the taste of the medieval story-teller, was that in which, when seeking to attain the lofty retreat of his lady love by using a basket as a hoist, he was left suspended in the air by her and exposed to the ridicule of his fellow citizens the following morning.

These legends attained a widespread distribution and evidently were highly popular. They appear repeatedly in the literatures of Europe. While the reasons of their popularity are obvious, it is not so easy to say why they should have been attached to Virgil. Comparetti, the Italian scholar, who made an exhaustive study of them towards the end of the last century, held that a reputation for magic inevitably came to be attached in the Middle Ages to any man of genius and that in the case of Virgil there was the additional inducement that he was held to have prophesied the coming of the Messiah.

Professor Spargo in his study of the Virgilian legend, does not agree that Comparetti's argument covers the facts. He points out that the version of these stories in which Virgil is the hero does not appear before the middle of the twelfth century, whereas on Comparetti's showing they would, undoubtedly, have been told at a much earlier date. With a ratiocinative skill worthy of a detective of fiction, he then tracks down each story of the Virgilian saga to its probable origin, and demonstrates its character as a piece of folk-myth which came to be attached to Virgil, primarily as a local celebrity at Naples, and secondarily as a centre of attraction for any similar type of fable. His study of the basket story, which he traces to a dual origin in the Orient and Germany—he refrains from mentioning Falstaff in the buckbasket as one of its developments—is a convincing analysis of a curious literary stream, which might be carried further in a future study.

Scientific Research and Social Needs. By JULIAN HUXLEY. (Watts & Co. 7*s.* 6*d.*)

Professor Huxley's new book appears at an opportune moment. It is an extended version of his "talks," with the discussions, given at the B.B.C. last winter, on the application of scientific research to practical needs in Great Britain considered from various points of view. The survey, admittedly imperfect, of the fields in which science is making advances in methods of production and invention of new products in substitution for old—in agriculture, in the production of food, of textiles, and in other provision for our material needs—has aroused much interest and makes very entertaining reading. But the justification for the time and labour which Professor Huxley has given to the book lies rather in the fact that it is a first attempt to grasp as an organic whole the function which science is performing in relation to the community, and at the same time to estimate the possibilities of further demands on the services and resources of scientific research in the promotion of the general good.

It will be appreciated that the author's enquiry is a vital preliminary to the discussion of the relation of the application of scientific research and scientific method in industry to unemployment and overproduction. Some hold it to lie at the root of many of our present difficulties. It is obviously futile to argue about such a remedy for our present economic crisis as a check on scientific research and invention, at least so far as practical application is affected, without precise knowledge of what science is doing and in what way.

In the long run these problems are matters for the economist and the politician; but although Professor Huxley is not concerned with economics and politics as such, the facts by which they are conditioned are susceptible, and, indeed, ought to be the subject of scientific study and analysis. He points out many gaps in our equipment for meeting social needs on sound lines, as, for example, in public health and education; but his most pregnant suggestion is implicit in his references to the absence of any attempt to study scientifically the consumption of products. The need of the moment is not so much the application of research to production as to the study of society and its problems. In fact, to attack effectively the ills of modern life, he argues that not less science but more is needed—scientific planning based upon exact knowledge of relevant facts and intelligently applied. This is the function of the scientist as a member of society. Professor Huxley has produced a stimulating book in which the attitude of impartial enquiry maintained throughout adds weight to its conclusions.

Law and Order in Polynesia. By H. IAN HOGBIN, M.A., PH.D. (Christophers. 12*s.* 6*d.*)

Dr. Hogbin's study of Polynesia is based primarily on his own field-work in Ontong Java, and secondly on records relating to Tahiti, Samoa and Hawaii. Ontong Java, a coral atoll in the Western Pacific sometimes also known as "Lord Howe's Island," had in 1907 over five thousand inhabitants, but by 1928 they had dwindled to under seven hundred. In a short time, in all probability, the islanders will be extinct.

The inhabitants of Ontong Java are divided into two tribes, each with its own village. Each tribe consists of a number of joint families, but other social grouping divides them up into canoe-owning groups, house-owning groups, gardening groups and households. Each of these groups has its own special function which is the *raison d'être* of its existence. The tribe combines for unitary action only in connection with religion, this centring on the agricultural rites to which one month of the year is devoted. In addition to the social groupings already mentioned there is also the kinship grouping.

It is necessary to bear these details in mind to appreciate the bearing of Dr. Hogbin's researches. The difficulties of the study of law and order in a "savage" of "primitive" society, using these terms in a conventional sense, is that naturally there is no written code, and for the practical purpose of the investigator, no readily accessible body of customary law, as in most systems which come into the purview of jurisprudence. It has been usual to explain subservience to social regulation in primitive societies as due to custom or the influence of magic and religion, as seen in the taboo. Dr. Hogbin shows that the difficulties which arise from the application of these views to the comparative study of law disappear when the function of law is seen as the expression of a reciprocal obligation as between the members of the individual groups and as between groups. Thus any individual who may feel inclined to ignore to his own advantage a social regulation or, as we should put it, disobey the law, is restrained from such unsocial action, not by fear of punishment, whether at the hands of man or the spirits, but by the knowledge that present failure to follow the proper course of action will entail future loss when a reciprocal benefit should accrue. Thus the payment of produce as tribute to the chief rests not on force but on the knowledge that in the first place the chief protects the group and its land, and secondly that the produce is not solely for the use of the chief, but will ultimately be distributed for the benefit of all members of the community.

Dr. Hogbin's study, it will be seen, though dealing with a specific area of investigation, is of considerable importance for general theory. Its bearing in this respect is further demonstrated in an introduction by Dr. Malinowski, who deals with the theoretical and practical standpoint of this school of anthropological thought, of which he is the founder and principal exponent.

Oriental Studies in Honour of Cursetji Erachji Pavry. Edited by JAL DASTUR CURSETJI PAVRY, with a Foreword by A. V. WILLIAMS JACKSON. (Oxford University Press. 50*s.*)

Dasturji Pavry is an orientalist of great prestige. Upon his seventieth birthday seventy of his colleagues throughout the world combined to do him honour in the form of this composite work, which consists of essays on a very great variety of oriental subjects by these seventy authors.

A work of this kind is hardly suitable for criticism, nor can space permit even a catalogue of the articles, but every interest is catered for. Some will be glad to read of Indo-Persian architecture, or of the beginnings of Persian printing in India, or again of the Iranian Buddhism and its relations to Islam, written in German. It is little realised how great and far-reaching has been the effect of ancient Persian thought. We learn here that the Persians were the first Aryans with whom the Jews came into contact and the first who understood their hatred of idols. Persia not only protected Judaism, but enriched it with two of its fundamental ideas, the polarity of Good and Evil, and the concept of a Messiah who would bring justice and content to the downtrodden, ideas which lay at the very foundations of Christianity. Other essays tell of the influence of Iran even on Hellenic Syncretism and on the Shintoism of Japan.

There are essays on the cult of fire surviving in Christendom, as the yule log, Beltane fire and bonfires, which are tolerated, and the remarkable ceremony of fire renewal still surviving in Florence at the ancient Church of Holy Apostles, where they preserve the sacred flints sent from the Holy Sepulchre by Godfrey de Bouillon in 1099. There is an account of the beliefs and customs of the Druzes, based on an Arab work by al-Bukhari, who tells us that this mysterious people, although differing so markedly from Muhammedans, took the origin of their little-known faith from Muhammed bin Ismail ad-Dharzi, a supporter of the sixth Fatimite caliph between A.D. 996 and 1020. We have an account of the nautical instruments of the old Arab navigators, a discussion on the home of the Indo-Europeans which ends in a safe, agnostic conclusion, and an apology for that remarkable prince Antiochus IV, surnamed Epiphanes, whose character was so blackened by Jewish propaganda that he is abused equally by the prophet Daniel, Livy, Polybius and Diodorus; although generally regarded as a Hellene, he was by blood rather a Persian, a fact which explains much.

A great deal of the book will appeal only to oriental philologists, but such articles as those referred to above will provide good reading for every educated man.

The Behaviour of Animals. By E. S. Russell. (Arnold. 10*s.* 6*d.*)

It is one thing to observe and quite another to be able to interpret one's observations. This is true throughout science and particularly in the study of animal behaviour. This admirable book is intended to make clear the principles on which the interpretation of observations should be based. Some schools of biological thought encourage the view which regards an animal merely as a bundle of mechanisms responding to exterior stimuli; Dr. Russell approaches the subject from another angle by regarding an animal as an individual entity, thus going beyond the purely mechanistic view. He is right to stress the importance of full and accurate records of normal behaviour in animals as well as instances of exceptional behaviour, since the latter are fully intelligible only when considered in relation to normal activities. The observation of everyday behaviour provides, as the author says, a fruitful field for the amateur naturalist and sportsman. There is still much to be learned of animals in the wild state, particularly of the lower forms of life. This book is brief and simple in treatment.

Children of the Yellow Earth. By J. Gunnar Andersson. (Kegan Paul. 25*s.*)

In this very interesting book, Dr. Andersson takes us step by step from Chinese collieries to the origin of Man and his belief and arts, with the effect of geological conditions upon history. In fact, he makes the outlines of Chinese development comprehensible, for he produces much evidence to show its evolution through endemic growth.

The first step was *Sinanthropus pekinensis*, one of the earliest human types known, about whom a whole literature has already sprung up: this barely human savage lived at the very beginning of the Pleistocene, a period of intense river action deepening the old valleys into narrow cañons.

The next stage we see in the late Pleistocene, a race of sturdy hunters at Ordos in Mongolia, presumably ancestors of the nomad herdsmen of Central Asia. This was the arid period of the formation of the aeolian loess, when life must have been very uncomfortable and, apparently, the population sparse. Then there is a big gap until we suddenly come upon a very different stage of affairs at the close of the Neolithic Age. Heavy river action has begun, cutting deep and narrow ravines through the soft loess, with the result of depriving the dense, agricultural population of ten per cent. of its area. Evidence of seventy sites show a thriving population, and only a highly artistic people could produce the wonderful ceramics, thin, polished and painted, marking the transition from Neolithic to Bronze Age: it is almost, if not quite, identical with the ware found at Anau and in Southern Russia at Triepolje. These people were proto-Chinese, and this phase brings us down to the dawn of history in China about 1500 B.C.

Every page of this book gives us some interesting fact or account of some known fact, and it is abundantly and clearly illustrated. It is full of the romance of the seeker, and the reader shares the author's joy in discovery. We read, for instance, that the men of Yang Shao stage cultivated rice, evidence of a much milder, moister climate than to-day, when rice will not grow so far north. We read of Dr. Bahlin, the young Swedish palæontologist, who continued his work with true scientific detachment, regardless of the bandits and civil war that buzzed around his cave. We read of a rich fossil flora discovered in central Shansi with 103 recognisable species of which 70 were new.

There are chapters on Fecundity Rites, Hunting Magic, the Death Cult and Aphrodite's Symbol, giving a reason for many ancient designs, and of the world-wide esteem of the cowrie, and an explanation of the symbolism of the astonishing funeral urns of the P'an Shan graves.

Huxley. By E. W. MacBride. (Duckworth. 2*s.*)

Professor MacBride's eminence as a biologist lends weight to his interesting account of Huxley in a new volume of the series of "Great Lives." He does justice to Huxley's scientific labours and to his influence on the Victorian public. At the same time Professor MacBride, while admitting the honesty of Huxley's agnosticism, points out that his materialist views were bound to have an adverse effect on public morality, however much Huxley might protest against such deductions. The author's discussion of this critical point in Huxley's attitude is well worth attention.

Greek Geography. By Eric H. Warmington. (Dent. 5*s.*)

Mr. Warmington, well known for his excellent book (in collaboration with Dr. Cary) on *The Ancient Explorers*, has compiled a valuable guide to Greek geography for Messrs. Dent's "Library of Greek Thought" edited by Professor Ernest Barker. It contains all the relevant passages in the Greek authors, translated and arranged under the headings of cosmology, climatology, exploration and cartography. Naturally the third section is the longest and the most attractive; Hanno's account of his voyage down the West African coast and the references to Pytheas's voyage to Britain and Scandinavia are famous examples. But the other sections are important for those who desire to understand the Greek geographer's conceptions of the world. Mr. Warmington's long introduction is clear and illuminating. He begs us to remember that the Greeks lacked instruments of precision and thus could not construct accurate maps. The wonder is that, with all their disadvantages, they knew so much about the old world.

Caravans of the Old Sahara. By E. W. BOVILL. (Humphrey Milford, for the International Institute of African Languages and Cultures. 21*s.*)

Ex Africa semper aliquid novi. Certainly Mr. Bovill in his fascinating "introduction to the history of the Western Sudan" has given us something new and filled a very obvious gap in historical literature. For all but the specialist, that history begins with Mungo Park's discovery in 1796 that the Niger flows eastward—an elementary fact which till then had been unknown in Europe—and with Richard Lander's pioneer voyage in 1830-31 down the Niger from Busa to the sea, and Caillie's visit to Timbuktu in 1828. The swamps and forests of the coast lands to south and west and the Sahara to the north had veiled the Western Sudan from European eyes through the ages. Yet, as Mr. Bovill shows, the Sahara was no barrier to the Sudanese or to the Arabs and Berbers of North Africa. There were regular caravan routes of immense antiquity from the North African ports to the Niger to which Europeans were not admitted. Carthage probably traded with the Sudan. The Romans certainly did, and to them Mr. Bovill ascribes the introduction of the camel from Bactria which made a vast difference to travel and trade in the Sahara. After the Romans in North Africa came the Byzantines, the Vandals and the Arabs, and then Central and Western Africa became a sealed book to Europe for many centuries.

But native kingdoms in the Niger waxed and waned, and much gold was mined in Senegal, so that Morocco, Algiers and Tripoli were always deeply interested in Sahara trade. Mr. Bovill describes, for instance, the rise of the Almoravids, eleventh-century Moslem ascetics who bear a curious resemblance to the Wahabis of modern Arabia. These desperate fanatics overran Morocco and then conquered the whole of Moslem Spain, but their rule did not endure. Late in the sixteenth century the Moorish Sultan sent an army, mostly composed of European renegades, across the desert and conquered Timbuktu. These are but two out of the many strange episodes in Mr. Bovill's fascinating book, which ends with the geographical discoveries of the nineteenth century. The author pays a high tribute to the intellect and morals of the Sudanese, who are a hybrid people, descended from negro farmers and Berber herdsmen, "in whom all the finer qualities of the negro race are seen to the best advantage."

An Experiment with Time. By J. W. DUNNE. (Faber. 5*s.*)

In preparing the third and cheaper edition of his remarkable book, Mr. Dunne has enlarged it by a third and partly rewritten it. The main addition is an account of the experiment undertaken by a number of Mr. Dunne's friends in noting down their dreams and trying to relate them to past or future occurrences. On the whole the results seem very inconclusive, as was pointed out in *Discovery* when the first edition appeared in 1927. But that does not detract from the interest of Mr. Dunne's theory, still less from the astonishing cleverness of his exposition. Whether an absolutely non-mathematical person could follow the argument may be doubtful. But it is true to say that, with an elementary knowledge of geometry, anyone would understand Mr. Dunne's explanation of the Fourth and higher Dimensions, and of his theory that in dreams the dreamer appears sometimes to move out of one dimension of time into another. Serialism, as Mr. Dunne terms his main principle, is a fascinating idea, and we are glad to see that the author is to develop the matter more fully in a forthcoming book.

Whither Medicine? By JOSEF LOEBEL. (Sidgwick & Jackson. 7*s.* 6*d.*)

This book is less ambitious than its title, for it is not a forecast of the future of medicine, but merely, as the author says in the preface, "aspires to show a cross-section of medicine," and it is written with the "aim of awakening confidence in medicine"; and where such awakening is called for, this cogent and easily readable work should achieve its purpose.

A survey of the history of medicine is an excellent method of bringing home to a doubting reader the advantages of living in the present, but it has the drawback that the reader may ask himself whether the factors which prevented any notable progress in medicine for some fifteen centuries have ceased to operate. Dr. Loebel does not give the reader much opportunity for such reflection, but carries him along with a glowing and sometimes rather credulous optimism through the brilliant panorama which the recent advances in medicine present.

The picture of medicine in the past, which can so easily be gruesome, is enlivened with vivid anecdotes, of which some, such as the account of the disturbing way in which the laxative properties of phenol phthalein were discovered, may be new to English readers; but it is a pity that the author, perhaps from a fear of being technical, allows himself sometimes to be garrulous and resorts rather frequently the rhetorical question and exclamation marks. The translators seem to be not very familiar with the subject matter, and several small inaccuracies have escaped the proof-reader.

Three Essays on Sex and Marriage. By EDWARD WESTERMARCK. (Macmillan & Co. 12*s.* 6*d.*)

Since the publication of the first edition of his book on human marriage over forty years ago, Professor Westermarck has been recognised as the foremost authority on the history of this institution in all its forms and attendant circumstances. The acerbity with which his views have sometimes been attacked, especially since the issue of the last edition, is a tribute to their vitality.

In these three essays the author replies to his critics, more especially to those of the Freudian school—who have criticised him both directly and by implication in the development of psycho-analytic doctrine and the Œdipus complex in relation to the incest taboo—and to Dr. Briffault, the author of that voluminous work *The Mothers*. Professor Westermarck takes this opportunity to restate his views on such topics as incest, exogamy, group marriage, etc., in the light of the latest data of ethnographical research and the development of sociological theory. In this sense, these essays supplement the latest edition of his *History of Human Marriage*.

Photography as an Aid to Scientific Work. (Ilford Limited. Supplied on request.)

This is a conveniently handy list of photographic materials supplied by Ilford Limited, suitable for workers in the sciences. Many of the products included in it do not normally appear in the usual price-lists and announcements. As a result of recent laboratory research many plates of special character have been produced, notably in connection with astronomical work, and the development of infra-red plates is important. The list is arranged alphabetically under the heads of the various sciences; a final section deals with wedge-screens and filters.

Correspondence.

THE ATOM.

To The Editor of DISCOVERY.

Dear Sir,

May I reply briefly to Dr. A. S. Russell's review of my book in the July issue of *Discovery*, because for the sake of your readers interested in atomic structure, it is important to correct Dr. Russell's claim to have proved that the alternative atom is wrong. So far, no scientist has succeeded in proving this, though many have attempted to do so.

Dr. Russell says: "In point of exact fact, where it can be tested against the older view, it must be accounted to have failed. Now, the points at which he tests the new theory are (*a*) The Scattering of Alpha Particles by Nuclei; (*b*) The Ratio of Specific Heat; (*c*) Chemical Identity of Isotopes.

On the first point, Dr. Russell merely asserts that "the model comes a cropper." Since a *single* proof that the theory is wrong is more convincing than *several* unsubstantiated assertions, a formal demonstration of this failure should have been produced by Dr. Russell. I challenge him to do this, in your columns or elsewhere. He has overlooked the fact that there is an important difference between the recoil of the nucleus and the recoil of the orbital constituents of the atom.

His second point is that the ratio of specific heats of a monatomic gas such as argon would, on the new theory, be about 1.5, instead of 1.67, as ascertained by experiment. This argument is based on the greater moment of inertia of an argon atom on the alternative theory. But the Bohr atom of argon also has a finite moment of inertia. Now, the ratio of specific heats does not depend in the slightest degree on the *magnitude* of the moment of inertia, but is governed solely by the number of degrees of freedom. When, therefore, Dr. Russell says that my atom "breaks down also on the subject of specific heat," is it not Dr. Russell's attack which has broken down?

Finally, in regard to isotopes, the two isotopes of lithium, for example, can, if desired, be made chemically identical by giving the light isotope a "free" electror outside and a positive electron inside the structure. In making such a supposition I am in good company, because Rutherford himself recently suggested that the light isotope of lithium might emit positive electrons.*

I submit that Dr. Russell has failed to show that the new theory is wrong on the three points at which he criticises it, and I hope he will give it the more careful attention that any new theory not palpably wrong should receive.

Yours faithfully,

JOHN TUTIN.

London, E.C.

12th July, 1934.

*Rutherford, Proceedings Royal Institution, 1934. Vol. 28, pp. 287 to 288.

RELIGIOUS INTOLERANCE AND DOGMATIC ASSERTION.

To the Editor of DISCOVERY.

Sir,

In your June number you commented on Professor Huxley's article in the "Science and Religion" series as follows: "He makes the statement (that God is a human product) as if it were a matter of fact instead of being merely an assumption; and although theologians are frequently dogmatic on matters which likewise belong to the realm of opinion, this does not justify the same error on the part of other thinkers."

Since dogmatic assertion on matters of opinion is always to be deprecated, it strikes me as curious that you should have chosen this particular article as the text for your protest. Seven other articles in this same series had already appeared, most of which contained dogmatic statements on matters of opinion by "other thinkers"; yet you passed them all by without comment. It leaves one with the unfortunate impression that you take sides with the theologians in tolerating dogmatic assertion when it is in favour of religion, but that you are swift to condemn it when it is unfavourable to religion.

This impression is further heightened by your own assertion that you believe most readers will dissent from Professor Huxley's conclusion. Were it not for the social and legal disadvantages which still fall upon those who openly profess Atheism, I venture to suggest that your estimate of your readers' opinions would prove to be surprisingly at fault. Religious intolerance of criticism, with its inevitable tendency to forcible suppression of adverse opinion, is a far greater evil to the community than any amount of dogmatic assertion. It grieves me, therefore, to find that the editor of so excellent a paper as DISCOVERY should deem it necessary to condemn the latter while so obviously condoning the former.

Yours faithfully.

C. S. FRASER.

Nalderswood, Near Reigate.

11th July, 1934.

[As we stated in our last issue, we felt obliged to correct the impression, implied in Professor Huxley's article, that belief in God is incompatible with a scientific approach to the question at issue. This surely argues a dogmatic refusal on the author's part even to hear the other side of the case, which is *ex hypothesi* unscientific. Even though our correspondent were correct, which we are not prepared to admit, in stating that most of the seven other articles in the series contained dogmatic statements on matters of opinion, he must admit that none of the seven authors regards the opinions of the opposite camp as unworthy a hearing. "The social and legal disadvantages which still fall upon those who openly profess Atheism," if they exist, exist mainly because of the rigidity of the atheists themselves in refusing to admit non-atheists to equal status in the ranks of honest searchers after Truth.—ED.]

To the Editor of DISCOVERY.

Sir,

I was glad to see your editorial note on Professor Huxley's article. I have long been a great admirer of his scientific work and of his literary style. But when he says in effect that a Christian cannot have a scientific mind, or, to put it in a more homely way, that a Christian must be a muddle-headed fellow, it is time that he were taken to task. I have known too many able men who were at once Christians and scientists to attach any importance to Professor Huxley's assertion. It merely shows that, like other brilliant people, he has his little human failings. The Christian Church will carry on as before.

Yours, etc.,

EDWARD G. HAWKE.

17th July, 1934.

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